UNIVERSITY OF ILLINOIS

Agricultural Experiment Station

SOIL REPORT No. 24

ADAMS COUNTY SOILS

By J. G. MOSIER, F. W. WASCHER, W. R. LEIGHTY, AND H. J. SNIDER

Prepared for Publication by L. H. SMITH

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IN RECOGNITION

The Soil Survey of Illinois was organized under the supervision of the late Dr. Cyril G. Hopkins. The work progressed for eighteen years under his guidance and the first eighteen soil reports bear his name as senior author. On October 6, 1919, Dr. Hopkins died in a foreign land in the service of the American Red Cross. It is the purpose to carry on to completion this great work of the Illinois Soil Survey in the spirit, and along the same general plan and lines of procedure, in which it was begun.

INTRODUCTORY NOTE

It is a matter of common observation that soils vary tremendously in their productive power, depending upon their physical condition, their chemical composition, and their biological activities. For any comprehensive plan of soil improvement looking toward the permanent maintenance of our agricultural lands, a definite knowledge of the various existing kinds or types of soil is a first essential. It is the purpose of a soil survey to classify the various kinds of soil of a given area in such a manner as to permit definite characterization for description and for mapping. With the information that such a survey affords, every farmer or land owner of the surveyed area has at hand the basis for a rational system of improvement of his land. At the same time the Experiment Station is furnished an inventory of the soils of the state, upon which intelligently to base plans for those fundamental investigations so necessary for solving the problems of practical soil improvement.

This county soil report is one of a series reporting the results of the soil survey which, when completed, will cover the state of Illinois. Each county report is intended to be as nearly complete in itself as it is practicable to make it, even at the expense of some repetition. There is presented in the form of an Appendix a general discussion of the important principles of soil fertility, in order to help the farmer and land owner to understand the significance of the data furnished by the soil survey and to make intelligent application of the same in the maintenance and improvement of the land. In many cases it will be of advantage to study the Appendix in advance of the soil report proper.

Data from experiment fields representing the more extensive types of soil, and furnishing valuable information regarding effective practices in soil management, are embodied in form of a Supplement. This Supplement should be referred to in connection with the descriptions of the respective soil types found in the body of the report.

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ADAMS COUNTY SOILS

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PREPARED FOR PUBLICATION BY L. H. SMITH[1]

CLIMATE AND AGRICULTURAL PRODUCTION

Adams county is the most westerly county in Illinois. The south boundary is in a line with the geographical center of the state north and south; in other words, it is approximately 192 miles from the south line of Adams county to either end of the state. The county measures 30 miles north and south, and 32 miles east and west, embracing an area of about 850 square miles.

About one-fifth of the area of the county is bottom land, the major portion of which is included in the low lands of the Mississippi river. The upland in Adams county is occupied in larger part by timber soils and much of it is very rough and hilly. These hilly areas are interspersed by expanses of the more productive prairie soils.

The temperature of Adams county is characterized by a wide range between the extremes of summer and winter. The longest weather record in the county (which, however, covers but ten years) is at Quincy. The lowest temperature for this time was —20° in 1912 and 1918, while the highest was 108° in 1918, making for 1918 a range of 128 degrees, the greatest range for the ten years.

The average date of the last killing frost in spring is April 15; the earliest in fall, October 17. The growing season therefore is about 185 days long.

The average annual precipitation at Quincy from 1912 to 1921 was 33.78 inches. The average precipitation by months for this period was as follows: January, 1.65 inches; February, 1.31; March, 2.34; April, 3.46; May, 4.90; June, 4.92; July, 2.52; August, 3.25; September, 4.33; October, 2.16; November, 1.73; December, 1.28. The proportion of total rainfall occurring during each season was: winter, 12.5 percent; spring, 31.6 percent; summer, 31.6 percent; autumn, 24.3 percent. The year of heaviest rainfall in the ten years was 1915, when the precipitation was 48.17 inches; the driest year was 1912, when the rainfall was but 27.84 inches.

About 26 percent of the land in Adams county is better adapted to grazing than to the growing of ordinary tilled crops. In 1920, the census reported 3,844 farms, these farms having an average of 129.1 acres each, 97.1 acres of which were improved. Of these farms, 38.6 percent were operated by tenants, which was a decrease in tenantry of 5 percent in the last ten years.

The principal crops are corn, oats, wheat, rye, timothy, and clover. The Fourteenth Census of the United States (1920) reports the following as the acreage and yield of the more important crops. It must be remembered that these figures are for but a single year—that of 1919.

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Crops	*Acreage*	*Production*
Corn	94,498	3,594,497 bu.
Oats	45,498	1,403,422 "
Wheat	75,525	1,244,029 "
Rye	5,242	49,381 "
Soybeans	293	2,117 "
Timothy	11,286	12,615 tons
Timothy and clover mixed	19,246	21,257 "
Clover	7,882	7,822 "
Alfalfa	790	1,817 "
Silage crops	1,697	12,809 "
Corn for forage	9,844	18,807 "

The acreage of pasture is not given by the Census, but from other data it is found to be approximately 73,000.

The total value of the grains, hay, and seeds produced in 1919 was approximately 21⅓ million dollars.

The live-stock interests, including those of dairying, are of considerable importance, as shown by the following data taken from the Census of 1920.

Animals and animal products	*Number*	*Value*
Horses	17,741	$1,471,053
Mules	2,670	363,297
Beef cattle	23,947	1,341,454
Dairy cattle	15,853	983,385
Sheep	13,611	148,229
Swine	93,629	1,633,566
Poultry	90,329	381,791
Eggs and chickens	.....	1,040,876
Dairy products	.....	609,182
Wool	68,534 lbs.	37,567

Adams county is one of the great fruit-producing counties of the state, as shown by the following data:

Small fruit	
Strawberries	316,877 quarts
Raspberries	112,482 "
Blackberries and dewberries	20,969 "
Orchard fruit	
Apples	202,630 bushels
Peaches	1,712 "
Pears	13,734 "
Cherries	5,463 "
Grapes	140,626 pounds

SOIL FORMATION

The most important period in the geological history of the county, from the standpoint of soil formation, was the Glacial period, during which the material that later formed the soils was being deposited. At that time, snow and ice accumulated in the region of Labrador, west of Hudson Bay, and in the Rocky Mountains to such an amount that the mass pushed outward from these centers, especially southward, until a point was reached where the ice melted as rapidly as it advanced. As the ice advanced in these movements it buried everything, even the highest mountains, in its path. It would then recede slowly, and apparently normal conditions would be restored for a long period, after which another advance would occur. At least six of these great ice movements took place, each of which covered part of northern United States, altho the same parts were not covered every time.

In advancing from the distant northern centers of accumulation, the ice gathered up all sorts and sizes of material, including clay, silt, sand, gravel, boulders, and even large masses of rock. Some of these materials were carried several hundred miles, and the coarser masses rubbed against the surface rocks or against each other until largely ground into rock powder, which now constitutes much of the soil. When, thru the melting of the ice, the limit of advance was reached, the material carried by the glacier was dropped, accumulating in a broad, undulating ridge or moraine, called a lateral moraine if formed at the side of the glacier, and a terminal moraine if formed at the end. If the ice melted more rapidly than the glacier advanced, the terminus of the glacier would recede, and the material would be deposited somewhat irregularly over the land, back of the moraines. Such a formation is known as a ground moraine. A glacier often would advance again, but not so far as before; or it would remain stationary, and another moraine would be built up. These moraines or ridges have a steep outward slope and a very gradual inward slope.

A pressure of forty pounds per square inch is exerted by a mass of ice one hundred feet thick, and these ice sheets may have been hundreds or even thousands of feet in thickness. The materials carried along in the ice, especially the boulders and pebbles, became powerful agents for grinding and wearing away the surface over which the ice passed. Preglacial ridges and hills were rubbed down, valleys were filled with the debris, and the surface features were changed entirely. The mixture of materials deposited by the glacier is known as boulder clay, till, glacial drift, or simply drift.

The material transported and deposited by a glacier varied with the character of the rocks over which it passed. Granites, limestones, sandstones, shales, etc., were encountered by the glacier, and both large and small masses of these were torn from their resting places by the enormous denuding power of the ice; they moved along with the glacier, were ground up more or less together, and were later deposited as the ice melted.

The names of the glaciers that had some part, either directly or indirectly, in the formation of the soils of Illinois are as follows: (1) The Nebraskan, which did not touch Illinois. (2) The Kansan, which covered parts of Hancock and Adams counties. The Yarmouth soil was developed from the surface of the Kansan glacial material. This soil was entirely covered by the next glacier. (3) The Illinoisan, which covered all of the state except the northwest corner (practically all of Jo Daviess county), the southern part of Calhoun county, and the seven southernmost counties. The Sangamon soil was formed from the surface of the Illinoisan drift. (4) The Iowan, which covered a part of northern Illinois. The area covered by this advance is difficult to determine because of the later glaciations. At about the close of the Iowan glacial advance, a wind deposit known as loess was laid down. The surface of this loess was formed into the Peorian soil, which was nearly all buried by the early Wisconsin glaciation. (5) The early Wisconsin glaciation, which covered the northeastern part of the state as far west as Peoria and south to Shelbyville. (6) The late Wisconsin glaciation, which extends to the west line of McHenry county and south to the town of Milford in Iroquois county.

THE GLACIATIONS OF ADAMS COUNTY

Only two of these glacial advances reached Adams county. The first was the Kansan, which came from the west or northwest, crossed the Mississippi river, and probably covered all except the southeast part of the county. A long period elapsed, the glacier melted, and a new soil was formed from the material deposited. Then another glacial advance occurred. This time the glacier (the Illinoisan) came from the northeast and covered the entire county, probably crossing the Mississippi river. It built up a moraine that extends diagonally across the county from southeast to northwest. This ridge, which was without doubt continuous at one time, has been divided by stream action into five short ridges which show very clearly the trend of the moraine. Another small ridge occurs about three miles east of the river at Quincy. Still another short moraine is found near Camp Point.

A later glacier, the Iowan, covered the northern part of the state, but did not reach Adams county. However, when it melted, large quantities of rock flour, or ground-up rock, were carried south and deposited on the flood plains of the rivers. From these flood plains the wind carried it on to the upland adjoining, making deposits varying in depth from 5 to 50 feet. This formation is called loess, and is made up largely of fine sand and still finer material (silt). The loess buried an old soil called the Sangamon soil.

The thickness of the glacial drift in Adams county varies from a few feet to 165 feet, but the average depth is not far from 65 feet. The deeper deposits represent an old pre-glacial valley which was filled with glacial drift or in which the drift was piled up in the form of a moraine. The deepest deposit found is near Coatsburg. Here a black soil two feet thick was encountered at a depth of 100 feet. This soil represents a period of normal conditions between glaciers, and is known as the Yarmouth soil, formed from Kansan drift.

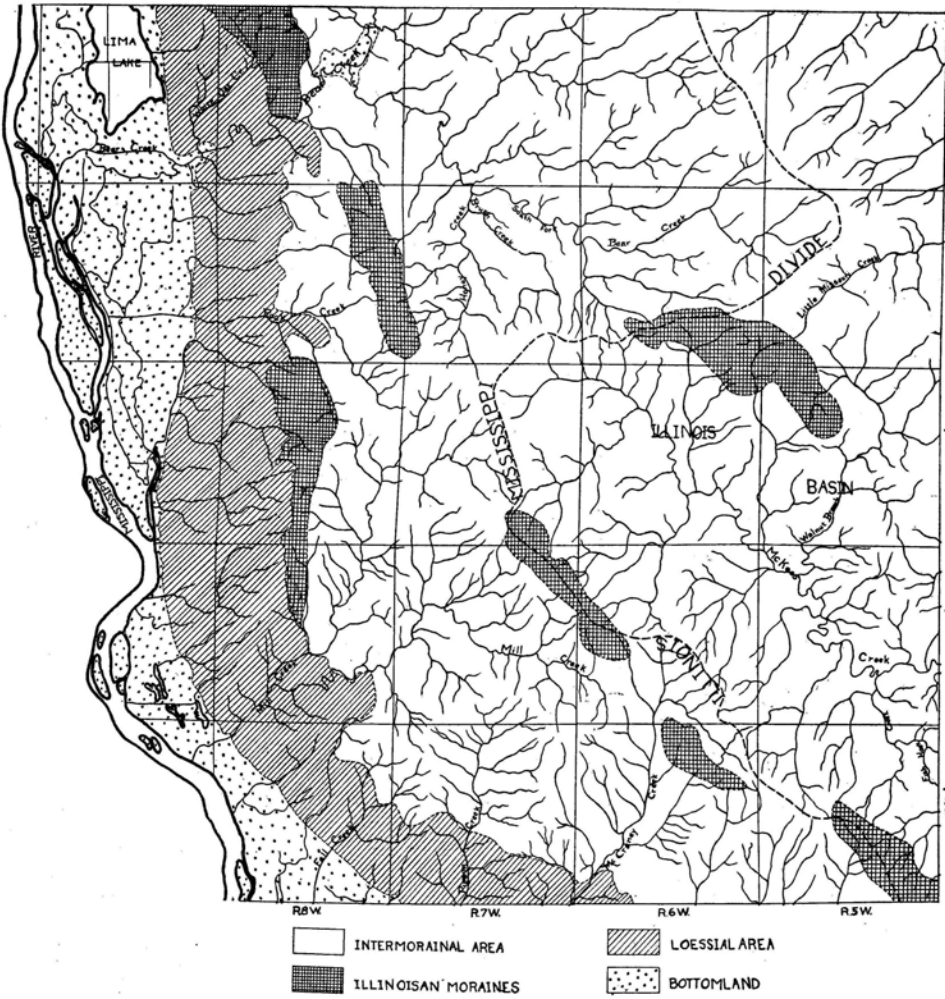
The drift deposited by the Kansan glacier is in many places made up of a gray to yellow sand, while that left by the Illinoisan is a very heavy, compact clay with some gravel, usually of a blue color where the iron has not been oxidized. Very few boulders occur in the drift of either glacier.

Altho the county has been covered by glaciers, the glacial drift does not constitute any large part of the material from which the soils have been directly derived. A layer of wind-blown, or loessial, material that varies from four to twelve feet or more in thickness, constitutes the material from which the soil has been formed. The coarser material was deposited within four or five miles from the edge of the bottom land, giving the soil in those localities a fine sandy appearance. Often where much erosion has occurred, the loess has been all removed, in which case the soil may be formed from glacial drift, but this occurs only in small patches.

PHYSIOGRAPHY AND DRAINAGE

Adams county has extremes in topography. The northeast part of the county has large areas of extremely flat, and originally poorly drained land. The west and south parts have extensive areas of hilly, almost untillable land mixed with areas of undulating, tillable land.

The present topography is largely the result of erosion, glacial deposition being of secondary influence. Two distinct drainage basins occur in the



MAP SHOWING THE DRAINAGE BASINS OF ADAMS COUNTY WITH MORAINAL, INTERMORAINAL, LOESSIAL, AND BOTTOM-LAND AREAS

county—those of the Mississippi and the Illinois rivers. The Mississippi basin is drained by Pigeon, Mill, and Bear creeks, the Illinois basin by McKees creek, and the northeast part of the county by tributaries of Crooked creek.

Following are the altitudes of some places in Adams county: Adams, 700 feet; Beverly, 856; Blacks, 728; Burton, 620; Camp Point, 740; Chattan, 715; Chestline, 740; Clayton, 744; Coatsburg, 769; Columbus, 732; Ewbanks, 733; Fair Weather, 839; Fall Creek, 451; Fowler, 733; Golden, 717; Kellerville, 730; La Prairie, 707; Lima, 620; Loraine, 644; Marblehead, 458; Mendon, 654; Paloma, 743; Payson, 726; Quincy, 488; Richfield, 735; Ursa, 588; Woodville, 664.

The highest point in the county is on the moraine in Section 34, southeast of Beverly, where the altitude is 858 feet. The Camp Point-Coatsburg ridge is 750 to 780 feet high; the ridge at Fowler, 700 to 750 feet. Low water in the Mississippi river at Quincy is 458 feet.

SOIL TYPES

About one-fifth of Adams county is bottom land and four-fifths upland. The soils, according to the survey, are divided into the following groups:

(a) Upland Prairie Soils, including the upland soils that have not been covered with forests—at least for any great length of time—and on which the luxuriant growth of prairie grasses has produced relatively large amounts of organic matter.

TABLE 1.—SOIL TYPES OF ADAMS COUNTY, ILLINOIS

Soil type No.	Name of type	Area in square miles	Area in acres	Percent of total area
	(a) Upland Prairie Soils (200, 500, 800)			
226, 526	Brown silt loam	102.71	65,734	12.11
228, 528	Brown-gray silt loam on tight clay	24.18	15,475	2.85
525.1	Black silt loam on clay	15.07	9,645	1.78
871	Brown fine sandy loam	20.89	13,370	2.46
		162.85	104,224	19.20
	(b) Upland Timber Soils (200, 500, 800)			
234, 534	Yellow-gray silt loam	232.19	148,602	27.38
235, 535	Yellow silt loam	181.13	115,923	21.36
874	Yellow-gray fine sandy loam	56.18	35,955	6.63
875	Yellow fine sandy loam	30.78	19,699	3.63
265, 565	Yellow sandy loam	8.37	5,357	.99
		508.65	325,536	59.99
	(c) Terrace Soils (1500)			
1526	Brown silt loam	.18	115	.02
1560	Brown sandy loam	.77	493	.09
1528	Brown-gray silt loam on tight clay	.20	128	.02
1534	Yellow-gray silt loam	2.18	1,395	.26
1536	Yellow-gray silt loam over gravel	.62	397	.07
1564	Yellow-gray sandy loam	.10	64	.01
		4.05	2,592	.47
	(d) Old Bottom-Land Soils (1300)			
1328	Brown-gray silt loam on tight clay	4.95	3,168	.58
1354	Mixed loam (small stream bottoms)	60.88	38,963	7.18
		65.83	42,131	7.76
	(e) Late Swamp and Bottom-Land Soils (1400)			
1426	Brown silt loam	33.95	21,728	4.00
1460	Brown sandy loam	6.54	4,186	.77
1415	Drab clay	8.68	5,555	1.02
1421	Drab clay loam	15.96	10,215	1.88
1421.1	Sandy drab clay loam	.30	192	.04
1454	Mixed loam (Mississippi overflow)	17.40	11,136	2.05
		82.83	53,012	9.76
	(f) Residual Soils (000)			
099	Rock outcrop	.41	262	.05
	Water	23.53	15,059	2.77
	Total	848.15	542,816	100.00

(b) Upland Timber Soils, including nearly all the upland areas that are now, or were formerly, covered with forests.

(c) Terrace Soils, including bench lands, or second bottom lands, formed by deposits from overloaded streams; and gravel outwash plains, formed by broad sheets of water arising from the melting of the glaciers.

(d) Old Bottom-Land Soils, including the low-lying land along streams other than the Mississippi river and formed of older materials than those of the late bottom lands.

(e) Late Swamp and Bottom-Land Soils, including the bottom lands of the Mississippi river and representing a newer formation than the old bottom lands.

(f) Residual, including rock-outcrop areas.

Table 1 gives a list of the types of soil found in Adams county, the area of each type in square miles and in acres, and also its percentage of the total area. The accompanying map shows the location and boundaries of each type of soil, even down to areas of a few acres.

For explanations concerning the classification of soils and the interpretation of the map and tables, the reader is referred to the first part of the Appendix.

INVOICE OF PLANT FOOD IN ADAMS COUNTY SOILS

SOIL ANALYSIS

The composition reported in the accompanying tables is, for the more extensive types, the average of several analyses. These analyses show that soils, like most things in nature, are variable; but for general purposes the average may be considered sufficient to characterize the soil type.

The chemical analysis of a soil, obtained by the methods here employed, gives the invoice of the total stock of the several plant-food materials actually present in the soil strata sampled and analyzed, but it should be understood that the rate of liberation, as explained in the Appendix (page 34), is governed by many factors.

For convenience in making practical application of the chemical analyses the results have been translated from the percentage basis and are presented here in terms of pounds per acre. In this, the assumption is made that for ordinary types, a stratum of dry soil 6⅔ inches thick weighs 2,000,000 pounds. It is recognized that this value is only an approximation, but it is believed that it will suffice for the purposes intended. It is, of course, a simple matter to convert these figures back to the percentage basis in case one desires for any purpose to consider the information in that form.

THE SURFACE SOIL

In Table 2 are reported the amount of organic carbon (which serves as a measure of the organic matter), and the total quantities of nitrogen, phosphorus, sulfur, potassium, magnesium, and calcium contained in 2 million pounds of the surface soil (the plowed soil of an acre about 6⅔ inches deep) of each type in Adams county.

TABLE 2.—PLANT FOOD IN THE SOILS OF ADAMS COUNTY, ILLINOIS: SURFACE SOIL
Average pounds per acre in 2 million pounds of surface soil (about 0-6⅔ inches)

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	(a) Upland Prairie Soils (200, 500, 800)							
226 526	Brown silt loam	47 090	3 630	1 000	720	32 490	5 270	8 860
228 528	Brown-gray silt loam on tight clay	35 720	3 170	860	710	31 700	3 450	6 930
525.1	Black silt loam on clay	44 220	3 660	990	800	31 270	5 560	9 310
871	Brown fine sandy loam	36 610	3 080	1 020	530	35 090	6 520	9 580
	(b) Upland Timber Soils (200, 500, 800)							
234 534	Yellow-gray silt loam	23 930	2 220	720	470	32 890	5 160	8 420
235 535	Yellow silt loam	20 730	1 900	620	430	29 730	4 790	4 550
874	Yellow-gray fine sandy loam	25 700	2 380	850	530	33 720	5 390	9 550
875	Yellow fine sandy loam	15 920	1 500	600	340	29 600	6 600	7 800
265 565	Yellow sandy loam	17 860	1 600	460	600	15 460	2 640	3 980
	(c) Terrace Soils (1500)							
1526	Brown silt loam	38 920	3 360	1 040	500	32 160	5 080	10 740
1560	Brown sandy loam	10 160	1 120	920	320	23 860	4 720	8 700
1528	Brown-gray silt loam on tight clay	16 780	1 960	800	500	29 120	5 020	9 300
1534	Yellow-gray silt loam	19 140	1 760	820	480	26 340	2 500	5 560
1536	Yellow-gray silt loam over gravel	18 140	2 140	860	440	33 580	5 060	9 900
1564	Yellow-gray sandy loam	12 900	1 520	620	460	22 400	3 280	7 640
	(d) Old Bottom-Land Soils (1300)							
1328	Brown-gray silt loam on tight clay	35 960	3 480	1 220	760	28 380	6 700	10 880
1354	Mixed loam	25 850	2 530	960	560	30 840	6 650	10 550
	(e) Late Swamp and Bottom-Land Soils (1400)							
1426	Brown silt loam	26 890	2 230	1 050	550	32 980	3 990	9 550
1460	Brown sandy loam	9 980	1 260	920	360	24 980	4 140	7 340
1415	Drab clay	36 410	3 240	1 320	710	32 170	8 630	10 700
1421	Drab clay loam	39 020	3 760	1 840	640	34 700	5 660	10 820
1421.1	Sandy drab clay loam	53 740	5 060	1 040	1 060	29 720	8 900	12 240
1454	Mixed loam	23 860	2 660	1 120	680	31 340	8 980	10 440

LIMESTONE AND SOIL ACIDITY.—In connection with these tabulated data it should be explained that the figures on limestone content and soil acidity are omitted not because of any lack of importance of these factors, but rather because of the peculiar difficulty of presenting in general averages adequate information concerning the limestone requirement. The limestone requirement for soils is extremely variable. It may vary from farm to farm, and even from field to field. Therefore no attempt is made to include in these tables figures purporting to represent for the various types the limestone content or the soil acidity present. The need for limestone should be determined on every farm and for each field individually. Fortunately this can be easily done by the simple tests described in the Appendix to this report, pages 36 and 37.

Because of the extreme variations frequently found within a given soil type with respect to the presence of limestone and acidity, no attempt is made to include in the tabulated results figures purporting to represent the average amounts of these substances present in the respective types. Such averages cannot give the farmer the specific information he needs regarding the lime requirements of a given field. Fortunately, however, very simple tests which

TABLE 3.—PLANT FOOD IN THE SOILS OF ADAMS COUNTY, ILLINOIS: SUBSURFACE SOIL
Average pounds per acre in 4 million pounds of subsurface soil (about 6⅔-20 inches)

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	(a) Upland Prairie Soils (200, 500, 800)							
226, 526	Brown silt loam	67 390	5 230	1 740	1 090	66 530	13 400	16 450
228, 528	Brown-gray silt loam on tight clay	42 460	3 480	1 360	920	64 380	12 780	15 800
525.1	Black silt loam on clay	57 980	4 740	1 400	1 200	63 120	12 380	18 600
871	Brown fine sandy loam	67 700	5 300	1 960	1 020	71 620	14 280	19 100
	(b) Upland Timber Soils (200, 500, 800)							
234, 534	Yellow-gray silt loam	23 210	2 610	1 350	640	67 150	16 220	15 400
235, 535	Yellow silt loam	14 520	1 770	1 000	600	54 270	12 480	6 630
874	Yellow-gray fine sandy loam	38 620	3 600	1 500	820	69 820	14 440	17 860
875	Yellow fine sandy loam	15 800	1 560	1 280	640	50 160	20 560	14 240
265, 565	Yellow sandy loam	21 680	1 960	880	960	30 320	6 520	6 720
	(c) Terrace Soils (1500)							
1526	Brown silt loam	49 280	4 160	1 680	1 120	65 600	14 000	20 920
1560	Brown sandy loam	22 360	2 680	1 920	800	47 880	9 760	18 680
1528	Brown-gray silt loam on tight clay	26 400	3 280	1 600	840	59 360	9 360	19 040
1534	Yellow-gray silt loam	22 720	2 320	1 720	680	56 040	8 040	16 080
1536	Yellow-gray silt loam over gravel	15 520	2 640	1 640	640	71 120	13 120	17 600
1564	Yellow-gray sandy loam	16 560	1 840	1 120	560	46 640	7 720	14 360
	(d) Old Bottom-Land Soils (1300)							
1328	Brown-gray silt loam on tight clay	36 200	3 800	1 640	1 000	57 160	12 480	17 560
1354	Mixed loam	40 840	4 230	1 840	960	61 320	13 350	20 690
	(e) Late Swamp and Bottom-Land Soils (1400)							
1426	Brown silt loam	45 330	3 410	2 000	890	65 880	7 770	18 670
1460	Brown sandy loam	17 480	2 240	1 840	920	49 520	8 400	15 440
1415	Drab clay	42 540	4 240	2 000	840	63 140	15 300	19 680
1421	Drab clay loam	49 280	4 720	2 800	960	67 080	13 800	18 640
1421.1	Sandy drab clay loam	47 320	4 760	1 360	1 080	57 640	16 800	27 680
1454	Mixed loam	33 480	3 000	1 480	800	57 280	15 720	19 320

LIMESTONE AND SOIL ACIDITY.—See note in Table 2.

can be made at home will furnish this important information, and these tests are described on pages 36 and 37 of the Appendix.

Altho the variation among the different types of soil of Adams county with respect to the quantity of the plant food elements is not so extreme as is found in many other counties, nevertheless there are wide fluctuations, as a comparison of the figures in Table 2 will show. For example, it may be noted that one type of soil contains 4½ times the quantity of nitrogen as another (compare drab clay loam of the bottom lands with brown sandy loam of the terrace soils). The supply of phosphorus in the surface stratum of the different types varies, as it happens, in practically the same degree, the range being from 1,840 pounds per acre in the drab clay loam to 460 pounds in yellow sandy loam. A sulfur content of 340 pounds per acre is found in the yellow fine sandy loam, while

TABLE 4.—PLANT FOOD IN THE SOILS OF ADAMS COUNTY, ILLINOIS: SUBSOIL
Average pounds per acre in 6 million pounds of subsoil (about 20-40 inches)

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	(a) Upland Prairie Soils (200, 500, 800)							
226, 526	Brown silt loam	33 330	3 750	2 400	990	96 000	30 530	29 700
228, 528	Brown-gray silt loam on tight clay	29 550	3 870	2 220	1 290	91 470	33 330	26 430
525.1	Black silt loam on clay	38 940	3 600	2 040	930	89 010	37 260	29 850
871	Brown fine sandy loam	42 990	4 320	2 700	1 080	105 810	30 420	29 670
	(b) Upland Timber Soils (200, 500, 800)							
234, 534	Yellow-gray silt loam	20 990	2 760	2 750	690	98 640	35 380	27 850
235, 535	Yellow silt loam	14 800	2 220	1 360	1 320	75 240	20 320	9 060
874	Yellow-gray fine sandy loam	22 080	2 880	3 060	1 140	98 580	31 470	29 040
875	Yellow fine sandy loam	19 200	1 860	1 260	600	64 560	33 120	24 240
265, 565	Yellow sandy loam	24 000	2 940	1 080	900	55 140	14 880	9 780
	(c) Terrace Soils (1500)							
1526	Brown silt loam	38 520	3 540	2 520	1 080	93 240	36 180	37 560
1560	Brown sandy loam	16 380	2 280	2 580	780	70 320	13 800	27 360
1528	Brown-gray silt loam on tight clay	28 260	3 780	2 640	1 080	97 500	18 120	26 700
1534	Yellow-gray silt loam	17 760	2 280	2 880	780	82 440	23 520	25 440
1536	Yellow-gray silt loam over gravel	11 940	3 180	3 960	900	107 160	28 740	26 220
1564	Yellow-gray sandy loam	15 600	1 980	1 800	600	70 440	15 780	22 320
	(d) Old Bottom-Land Soils (1300)							
1328	Brown-gray silt loam on tight clay	12 720	2 640	1 800	780	85 440	21 840	29 940
1354	Mixed loam	30 920	3 500	1 880	1 300	83 640	18 420	27 020
	(e) Late Swamp and Bottom Land-Soils (1400)							
1426	Brown silt loam	68 150	5 540	3 320	1 240	96 100	13 200	27 660
1460	Brown sandy loam	17 820	2 280	2 640	1 020	70 440	12 120	21 360
1415	Drab clay	36 720	4 050	2 250	1 020	86 370	24 630	41 610
1421	Drab clay loam	19 860	3 660	3 240	1 140	97 020	13 080	30 480
1421.1	Sandy drab clay loam	29 640	3 660	3 240	1 140	90 120	23 160	36 720
1454	Mixed loam	23 220	2 880	1 980	900	83 940	22 920	27 900

LIMESTONE AND SOIL ACIDITY.—See note in Table 2.

in the sandy drab clay loam there are 1,060 pounds of this element. The magnesium varies in the different types from 2,500 to 8,980 pounds, and the calcium content ranges from 620 to 12,240.

It is important to note that some of the plant-food elements are present in very limited quantities as compared with crop requirements. Some simple computations are of interest in this connection. Assume, for example, that a four-field crop rotation of wheat, corn, oats, and clover yields 50 bushels of wheat per acre, 100 bushels of corn, 100 bushels of oats, and 4 tons of clover hay. These are high yields, but not impossible, for they are sometimes obtained. It will be found that the most prevalent soil of Adams county, the yellow-gray silt loam, contains only enough total nitrogen in the plowed soil for the production of such yields to supply about four rotations.

With respect to phosphorus, the condition differs only in degree, this soil containing no more of that essential element than would be required for about ten crop rotations yielding at the rates suggested above. On the other hand, the amount of potassium in the surface layer of this common soil type is sufficient for more than 25 centuries if only the grain is sold, or for nearly 400 years if the total crops should be removed from the land and nothing returned.

These general statements relating to the total quantities of these plant-food materials in the plowed soil of the most prevalent type in the county certainly emphasize the fact that the supplies of some of these necessary elements of fertility are extremely limited when measured by the needs of large crop yields for even one or two generations of people.

THE SUBSURFACE AND SUBSOIL

In Tables 3 and 4 are recorded the amounts of plant food in the subsurface and the subsoil of the different types. It should be remembered, however, that these supplies are of little value unless the top soil is kept rich. These tables also show great stores of potassium in the prevailing types of soil but only limited amounts of nitrogen and phosphorus, in agreement with the data for the corresponding surface samples.

DESCRIPTION OF INDIVIDUAL SOIL TYPES

(a) UPLAND PRAIRIE SOILS

The upland prairie soils of Adams county cover an area of 162.85 square miles, or about one-fifth of the entire area of the county. They usually occupy the less eroded areas of the upland. They are black or dark brown in color, owing to their high organic-matter content. This land in its virgin condition was covered with prairie grasses, the partially decayed roots of which have been the principal source of the organic matter. The flat, poorly drained areas contain the greater amounts of organic matter, owing to the more luxuriant growth of the grasses there and to the excessive soil moisture which provided conditions better adapted for the preservation of their roots.

Brown Silt Loam (226, 526)

Brown silt loam is the third most extensive type in Adams county. It covers an area of 102.71 square miles, or 12.11 percent of the area of the county. It is widely distributed over the county, but the greatest area occurs in the four northeast townships.

This type occupies the slightly undulating to almost flat upland, some of which may at one time have been overspread for a short period by timber but not sufficiently long to have produced any marked change in the character of the soil. These forests consisted largely of black walnut, wild cherry, hackberry, ash, hard maple, and elm. A black walnut soil is recognized generally by farmers as being one of the best timber soils because of the fact that it still contains a large amount of organic matter, characteristic of prairie soils. After the growth of several generations of trees, the organic matter generally becomes so reduced that such a

soil would be classed as a timber type instead of a prairie type. In the southern and western parts of the county, the brown silt loam is confined to the divides that have not been dissected to any extent by the erosion of streams. The surface drainage is usually good, altho in a few cases in the northeastern part, artificial drainage is very desirable. The soil was formed from wind-blown loessial material which covers the county to a variable depth, usually more than three feet.

The surface soil, 0 to 6⅔ inches, is a brown silt loam varying on the one hand to black as it grades into black silt loam on clay (525.1), and on the other hand to brownish gray or grayish yellow as it grades into either brown-gray silt loam on tight clay (528) or yellow-gray silt loam (534). It contains a sufficient amount of the coarser constituents (coarse silt and fine sand) to make it work easily, and yet enough fine silt and clay to give it stability and cause it to granulate under proper conditions. It contains from 60 to 70 percent of silt, 10 to 15 percent of clay, and from 15 to 40 percent of sand, mostly fine. The organic-matter content varies from 3.5 to 4.5 percent, with an average of approximately 4.1 percent, or 41 tons per acre. There is less organic matter in the more rolling areas, and in places where the type grades into the timber soil. In the poorly drained parts, the larger moisture content encouraged a ranker growth of grasses and at the same time furnished more favorable conditions for the preservation of their roots.

The natural subsurface stratum is a silt loam varying in thickness from 6 to 12 inches and in color from a dark brown to a yellowish brown. Both color and depth vary with the topography, the type being lighter in color and shallower on the more rolling areas. The same effect is produced where the type grades into the timber soil. The subsurface as sampled (6⅔ to 20 inches) contains about 2.9 percent of organic matter, or 58 tons per acre.

The natural subsoil begins at a depth of 12 to 18 inches beneath the surface. It is a yellowish, drabbish, or grayish clayey silt or silty clay. It is somewhat plastic when wet, and has a tendency to be somewhat compact and more impervious than in most other areas of the state where the type occurs. Because of this condition, drainage does not take place so readily as in the type generally.

Management.—When the virgin brown silt loam was first cropped, the soil was in fine tilth, worked easily, and large crops could be grown with much less work than now. Continuous cropping, however, to corn or corn and oats with the burning of corn stalks, stubble, grass, and in many cases even straw, has destroyed the tilth in a great measure and now the soil is more difficult to work, washes badly, runs together, and bakes more readily. Unless the moisture conditions are very favorable, the ground plows up cloddy and unless well-distributed rains follow, a good seed bed is difficult to produce. The clods may remain all season. Much plant food is locked up in them and thus made unavailable, so that the best results cannot be obtained. This condition of poor tilth may become serious if the present methods of management continue; it is already one of the factors that limits crop yields. The remedy is to increase the organic-matter content by plowing under every available form of vegetable

material, such as farm manure, corn stalks, straw, clover, stubble, and even weeds.

The deficiency of organic matter in the soil is shown by the way the fall-plowed land runs together during the winter. Much more work is required to produce a seed bed than was formerly the case. The result is that corn is frequently planted in poorly prepared seed beds and as a consequence it "fires" badly. In the spring, fall-plowed land should be disked early and deeply for the purpose of conserving moisture, raising the temperature, and making plant food available.

The addition of fresh organic matter is not only of great value in improving the physical condition of this type of soil, but it is of even greater importance because of its nitrogen content and because of its power, as it decays, to liberate potassium from the inexhaustible supply in the minerals of the soil, and phosphorus from the phosphate contained in or applied to the soil.

For permanent, profitable systems of farming on brown silt loam, phosphorus should be applied liberally; and sufficient organic matter should be provided to furnish the necessary amount of nitrogen. On much of the type, limestone is already deficient. An application of 2 tons of limestone, and ½ ton of finely ground rock phosphate per acre every four years, with the return to the soil of all manure made from a rotation, will maintain the fertility of this type; altho heavier applications of phosphate may well be made during the first two or three rotations, and the first application of limestone may well be 4 tons per acre. If grain farming is practiced, the rotation may be wheat, corn, oats, and clover, with an extra seeding of clover (preferably sweet clover) as a cover crop in the wheat, to be plowed under late in the fall or in the following spring for corn; and most of the crop residues, including the clover chaff from the seed crops, should also be plowed under. In live-stock farming, the regular rotation may be extended to five or six years by seeding both timothy and clover with the oats, and pasturing one or two years. Alsike may well replace red clover at times, in order to avoid clover sickness. In either the grain or the live-stock system, alfalfa may be grown on a fifth field and moved every five years, the hay being fed or sold. Sweet clover is especially valuable on this type of soil because of its deep rooting habit and the effect that this has upon underdrainage.

For other suggestions regarding crop rotation systems, see page 42 of the Appendix. For results secured in field experiments on brown silt loam, see page 45 of the Supplement. On page 53 will be found a description of the experiment field located at Clayton in Adams county along with the results obtained.

Brown-Gray Silt Loam on Tight Clay (228, 528)

Brown-gray silt loam on tight clay is somewhat closely associated with brown silt loam and is widely distributed thruout the county. In topography it is usually flat—so much so that surface drainage is rather difficult. It covers an area of 24.18 square miles, or 2.85 percent of the area of the county.

The surface soil, 0 to 6⅔ inches, is a brown to grayish brown silt loam containing a perceptible amount of fine sand. This is quite evident after a

heavy rain, when the fine sand is washed out on to the surface. The organic-matter content is approximately 3.1 percent, or 31 tons per acre. As a general rule, this stratum does not contain quite so much clay as the average brown silt loam (526), and for this reason it is somewhat more pulverulent.

The natural subsurface is a silt loam varying in thickness from 6 to 12 inches and in color from brown to light gray. It is very low in organic matter. As a rule, the top two or three inches of the subsurface is a brown silt loam, while the lower portion of this stratum is gray. A considerable amount of coarse silt and fine sand is present. When dry, the stratum is decidedly gray. It is rather impervious to the downward movement of water, and so acts to some extent in preventing drainage. The subsurface as sampled (6⅔ to 20 inches) contains about 1.7 percent of organic matter, or 34 tons per acre.

The natural subsoil begins at a depth of 12 to 18 inches beneath the surface of the ground. It consists of a yellowish or brownish, compact, plastic, impervious clay, which renders drainage extremely difficult. As a rule, this impervious clay ends at 34 to 40 inches, and is followed by a yellow or grayish material much coarser in composition, quite friable, and not very plastic.

Management.—Much that was said in regard to the management of brown silt loam applies also to this type, especially in regard to organic matter. Methods should be undertaken for its permanent improvement. Frequently a farmer, instead of making improvement of a run-down soil, attempts to find a crop that will grow on it without improvement. As a result crops such as timothy are grown; and in some places, altho not in Adams county, redtop has been the crop of last resort. This is poor practice, since it only means a still further depletion of plant food.

After drainage, the first requirement in the improvement of this soil is limestone. Two to three tons per acre should be applied; this will put the soil in condition for the growing of legumes. The importance of legumes on this type of soil cannot be over-emphasized. They add nitrogen to the soil, and at the same time furnish a very valuable form of organic matter. The deep-rooting legumes open up the subsoil and allow better drainage; for this purpose sweet clover is especially desirable. All available organic matter, in any form, should be turned back into the soil. A half-ton of rock phosphate each rotation is very desirable as a means of building up the phosphorus content in which the type is deficient.

Black Silt Loam on Clay (525.1)

Black silt loam on clay is found almost exclusively in the northeastern four townships of the county, occurring on the flat and poorly drained areas. The type covers 15.07 square miles, or 1.78 percent of the total area of the county.

The surface soil, 0 to 6⅔ inches, varies from a black silt loam to a black clayey silt loam, some small areas even passing into a black clay loam. The surface stratum contains about 3.8 percent of organic matter, or 38 tons per acre.

The natural subsurface extends to a depth of 17 to 20 inches, and is usually heavier than the surface soil. It is black in color, becoming lighter with increas-

ing depth. This stratum as sampled (6⅔ to 20 inches) contains about 2.5 percent of organic matter, or 50 tons per acre.

The subsoil varies from a black to a pale yellow clay, very heavy and somewhat impervious.

Management.—Altho this type is fairly well supplied at present with organic matter and nitrogen, it is very desirable that these materials be maintained or even increased. This is especially true of the organic matter, which is necessary in order to keep the soil in good physical condition and maintain desirable working conditions. Crop residues, farm manure, and legumes should be turned under. The soil is becoming acid, and it will therefore be necessary, in order to provide for the best growth of legumes, to apply about 2 tons of limestone per acre. A very desirable form of legume for this type is sweet clover, as its deep-rooting habit opens up the subsoil and thus promotes better drainage.

This type is fairly well supplied with phosphorus, yet it would be desirable to begin to increase the content of this element by applying a half ton of finely ground rock phosphate per acre about once every four or five years.

Drainage is very necessary. As a rule, farmers have the impression that this type will not tile-drain. It is true that it will not drain so well as brown silt loam (526) and many other types, but by keeping it well supplied with limestone and growing deep-rooting legumes, there is no question but that it may be tile-drained satisfactorily.

Brown Fine Sandy Loam (871)

Brown fine sandy loam occurs as irregular patches on the western border of the upland, being confined within a strip about five miles wide along the Mississippi bluff line. The material from which it was made is derived from the bottom land of the Mississippi and has been carried and deposited upon the bluff by the wind. It is composed largely of fine sand and various grades of silt. The total area is 20.89 square miles, or 2.46 percent of the area of the county.

The surface soil, 0 to 6⅔ inches, is a brown fine sandy loam. It contains approximately 50 to 60 percent of fine sand, which gives it excellent working qualities and makes it well adapted for retaining moisture and moving it by capillarity. The organic-matter content is about 3.2 percent, or 32 tons per acre.

The natural subsurface of this type corresponds in depth to the standard sampling depth (6⅔ to 20 inches). It is a brown to yellowish brown, fine sandy loam, friable and pervious. The organic-matter content is about 2.8 percent.

The subsoil is a yellow, friable, pervious silt, containing a considerable percentage of fine sand.

Management.—This type is only fairly well supplied with the elements of plant food. It contains about 3,000 pounds of nitrogen per acre in the surface soil, and 1,000 pounds of phosphorus. The nitrogen will be used up more rapidly than the phosphorus and means should be taken to maintain or even increase the supply. Altho good crops may be grown in favorable years without paying much attention to nitrogen, yet the productiveness of the type may be decidedly increased by a little care in this regard. Farm manure, crop residues, and legumes are the means by which this element may be maintained or

increased, and the organic matter derived from these will enable the farmer to keep the soil in good tilth. There is, however, some acidity in the soil which always interferes with the growth of clover and alfalfa. In order to get the best results with legumes it is desirable even now that 2 or 3 tons of limestone per acre be applied and applications made often enough afterward to keep the soil in the best condition for growing legumes. The phosphorus content is somewhat low, and may well be increased by the application of a half-ton of rock phosphate for a number of rotations. Considered from the physical standpoint, there are very few soils in the state that are in better condition than this one; and every means should be employed to keep it up to its present standard.

(b) UPLAND TIMBER SOILS

The upland timber soils include nearly all the upland areas that are now, or have been, covered with forests. These soils contain much less organic matter than those of the prairie and hence are light brown, yellow, or gray in color. This difference is caused by the character of the vegetation that once covered them. In forests, the vegetable material (leaves and twigs from trees) accumulates upon the surface and is either burned or suffers almost complete decay. Grasses, which furnish large amounts of humus-forming roots, do not grow to any extent because of the shade of the trees. Moreover, the organic matter that had accumulated in the soil before the timber began growing is slowly removed thru various decomposition processes, with the result that in these timber soils generally the content of nitrogen and organic matter has become too low for the best growth of farm crops.

The total area of upland timber soils in Adams county is 508.65 square miles, or practically 60 percent of the area of the county.

Yellow-Gray Silt Loam (234, 534)

The yellow-gray silt loam is the most extensive type in the county, covering an area of 232.19 square miles, or 27.38 percent of the area of the county. It has been produced primarily by the long-continued growth of forests, which as a general rule developed along streams and slowly spread over the adjoining prairie. It varies in topography from flat to undulating and may be somewhat rolling where it passes into the eroded yellow silt loam (535).

The surface soil, 0 to 6⅔ inches, is a grayish yellow or brownish yellow silt loam containing from 20 to 35 percent of fine sand. It varies in physical composition to some extent, with the amount of erosion that has taken place, but in general it is quite uniform in its composition. It contains approximately 2 percent of organic matter, altho the amount of this element varies from about 1 percent, where much erosion has taken place, to 2.75 percent as it passes into the brown silt loam (–26).

The natural subsurface is from 5 to 12 inches thick and varies from a gray to a yellowish gray silt loam, passing into a clayey material. A decided change in color to that of gray usually occurs at a depth of 8 to 10 inches below the surface of the soil. The subsurface as sampled (6⅔ to 20 inches) contains approximately 1 percent of organic matter, or 20 tons per acre.

The natural subsoil begins at a depth of 12 to 18 inches. It is a yellow, grayish yellow, or brownish yellow clayey silt or silty clay that is usually rather plastic when moist.

Management.—The type is deficient in limestone, and low in organic matter, nitrogen, and phosphorus. As a rule, the soil is acid. The first requirement in its improvement is the correction of this acidity by the application of 2 to 4 tons of limestone per acre so that legumes may be grown satisfactorily. After this initial application, limestone should be applied often enough and in sufficient quantities to keep the soil in good condition for growing legumes. The condition of the soil with respect to acidity may easily be determined by making one of the tests described on pages 36 and 37.

The organic-matter and nitrogen contents are low, and since nitrogen is one of the elements contained in organic matter, any management that increases the organic-matter content will also increase the nitrogen. Crop residues, farm manures, and legumes should be turned into the soil. A rotation should be adopted that will provide for the frequent growing of legume crops. These should be largely turned under, or if fed the manure should be returned. Catch crops in grain may be used to advantage. By thus increasing the organic matter, the soil will be put in good tilth and in better condition to resist both drouth and excessive rains. The legumes that are grown are very important in another way. If the deep-rooting varieties are used, such as sweet clover, red clover, and alfalfa, the drainage conditions will be improved. Also the amount of run-off will be decreased because more water is absorbed during the rains and held in storage to serve during periods of drouth. Timothy, which is often grown as the principal crop on this kind of land, is not only of no benefit to the soil, but is actually a detriment. It would be much better to grow clover, or a mixture of clover and timothy.

The increase of the phosphorus content is very necessary. It would be well to apply from a half-ton to a ton of finely ground rock phosphate per acre once in each rotation until at least 2 or 3 tons per acre have been applied. On the more rolling parts of this type, washing is likely to occur, and here especially the organic-matter content should be increased and legumes grown. As a rule, the type does not require underdrainage, and yet there may be cases where it would be well to lay a tile in the draws to help prevent erosion.

For results from practical field experiments on yellow-gray silt loam, see page 57 of the Supplement.

Yellow Silt Loam (235, 535)

Yellow silt loam is very generally distributed over Adams county. It occurs mostly in very irregular areas as the broken and hilly land immediately adjoining the stream courses. It is very difficult to cultivate, and as a rule should be left in pasture. It is the second most extensive type in the county, covering a total of 181.13 square miles.

The surface soil, 0 to 6⅔ inches, is a yellow or brownish yellow silt loam which becomes somewhat gray upon drying after a shower. In some places erosion has exposed the yellow clayey subsoil. The stratum contains some fine

sand. The organic-matter content is low, there being about 1.8 percent, or only 18 tons per acre.

The natural subsurface is a yellow to grayish yellow silt loam, varying in thickness from 4 to 10 inches. This variation in depth is largely the result of erosion, and in some places the subsurface may be made up of the same material as the subsoil. The stratum sampled (6⅔ to 20 inches) contains about .6 percent of organic matter, or 12 tons per acre.

The natural subsoil is sometimes exposed on the surface in small patches where erosion has taken place, but it usually begins at a depth of 10 to 16 inches and is a yellow clayey silt or silty clay. In some places in part of its depth it partakes of the character of fine sandy loess, while in other places the subsoil to a depth of 40 inches may be made up of glacial till, which here is usually a heavy clay with some sand and fine gravel. It contains about .4 percent of organic matter.

Management.—Altho the total area of yellow silt loam is large, making up more than a fifth of the county, it is of little importance agriculturally because most of it is so hilly as to render its cultivation either extremely difficult or else impossible. It is therefore devoted almost entirely to pasture. Some areas might be cultivated were it not for the danger of loss from erosion. Even if the land is cleared and put under cultivation, its life under the ordinary methods of cultivation is only a few years. It then becomes practically unproductive. It is one of the most difficult soils in the state to manage.

This type in general is low in practically all the elements of plant food except potassium. It is also decidedly acid, particularly in the subsurface. With present methods it is of little use to apply plant food, because it would be washed away in a short time. It is, however, desirable to apply limestone at the rate of 3 or 4 tons per acre in order to furnish the best conditions for the growing of legumes, which are the best crops for preventing erosion. The amount of pasture produced on this hilly land may be greatly increased by the application of limestone and the growing of sweet clover. Sweet clover provides a large amount of excellent pasture and even the growth of blue grass will be greatly encouraged by the nitrogen that is furnished by the sweet clover. If the land is to be cultivated, sweet clover will add organic matter and will help to retain the soil. Thru the penetration of its roots it will loosen all strata of the soil so that much more water will be absorbed, thus preventing a large amount of run-off. The water that is absorbed into the soil is always of benefit, while that which runs off is always detrimental. All gullies that start in the field should be put under control at once. Probably the best way to do this is to fill them, apply limestone, and sow to sweet clover. A surface application of manure or straw may be necessary in order to prevent erosion until the sweet clover gets a start. (See Bulletin 207, Washing of Soils and Methods of Prevention). For methods of improving yellow silt loam, see the discussion of the Vienna experiment field on page 60 of the Supplement.

Yellow-Gray Fine Sandy Loam (874)

Yellow-gray fine sandy loam is found only in the deep loess area, which is within five miles of the Mississippi bluff. The topography is undulating to

slightly rolling. The total area is 56.18 square miles, or 6.63 percent of the area of the county.

The surface soil, 0 to 6⅔ inches, is a light brown to yellow fine sandy loam containing about 2.2 percent of organic matter, or 22 tons per acre.

The natural subsurface varies from 4 to 10 inches in thickness and is a yellow to a light brownish yellow fine sandy loam. The stratum as sampled (6⅔ to 20 inches) contains about 1.7 percent of organic matter, or 34 tons per acre.

The subsoil is a yellow fine sandy silt, friable and porous, and contains about .6 percent of organic matter.

Management.—This type is sufficiently undulating for good drainage. It is an excellent soil in its texture, but it is somewhat low in organic matter, nitrogen, and phosphorus. It is becoming acid, and if legumes are to be grown satisfactorily limestone must be applied at the rate of 2 to 3 tons per acre, the applications to be repeated as the soil requires. The growing and turning under of legumes, together with the farm manure and crop residues, will increase the content of organic-matter and nitrogen and will keep the soil in good physical condition.

It will soon be necessary to begin the application of phosphate, and this may give good results even now. Finely ground rock phosphate should be applied at the rate of a half-ton to a ton per acre every five or six years until the amount of phosphorus now present in the soil is almost doubled.

There are some places where washing will take place to an injurious extent unless measures are taken to prevent it. This can be largely prevented by growing legumes, by incorporating organic matter, and by keeping a cover crop on the land as much as possible.

Yellow Fine Sandy Loam (875)

Yellow fine sandy loam occurs in the deep loess area and along the stream courses. There is not so much eroded land in the sandy area along the streams in the western part of the county as is found in the more silty land along the streams in the eastern part. This is due, probably, to the greater porosity of the soil, which allows it to absorb moisture, and thus diminishes the run-off. The total area of this type is 30.78 square miles, or 3.63 percent of the area of the county. The topography is hilly and in many places very steep. This land should be cultivated only with the greatest care.

The surface soil, 0 to 6⅔ inches, is a yellow to light brownish yellow fine sandy loam containing about 1.4 percent of organic matter, or 14 tons per acre.

The subsurface soil, 6⅔ to 20 inches, is a yellow, slightly clayey silt containing about .7 percent of organic matter, or 14 tons per acre.

The subsoil is a yellow clayey silt containing .5 percent of organic matter.

Management.—The first requisite in the improvement of this type is the application of about 3 tons of limestone per acre. This soil is acid, especially in the surface and subsurface, and the limestone is necessary in order to correct the acidity and put the soil into condition for growing clovers. The content of nitrogen and organic matter is very low, and crop residues, legumes, and farm

manure should be turned under in order to increase these constituents. The total nitrogen content of the plowed soil is only 1,500 pounds per acre, which is entirely too low for profitable crops. It would be well to grow sweet clover or some other legume crop two or three years out of every four. Legumes may be grown as catch crops, even when the regular crop is grown. Sweet clover may be seeded in wheat and the year's growth turned under for corn; corn may be followed by soybeans, and that by wheat. Or any similar rotation may be used in which the legume is grown frequently.

The phosphorus content of the surface soil is only 600 pounds per acre; this should be augmented as rapidly as possible. The best plan is to apply a half-ton to a ton of finely ground rock phosphate per acre once in each rotation.

This type is better adapted to pasture than to anything else because of the difficulty of cultivation and of preventing washing. The suggestions which were made under yellow silt loam (535) for preventing washing will apply here also. See Bulletin 207, Washing of Soils and Methods of Prevention.

Yellow Sandy Loam (265, 565)

Yellow sandy loam occurs in eroded areas. There is a region in the southern part of the county in Townships 2 and 3 South, Ranges 6 and 7 West, in which the deeper subsoil is composed of sand. Where erosion has occurred, especially on the slopes, the sand is exposed, and this gives rise to the sandy loam type. The sand is either gray or bright yellow in color. The type covers an area of 8.37 square miles, or .99 percent of the total area of the county. In topography it is hilly and on the whole is very poor for agricultural purposes.

The surface soil, 0 to 6⅔ inches, is a yellow or brownish yellow sandy loam containing about 1.5 percent of organic matter, or 15 tons per acre. The sand is medium in grade and varies widely in amount.

The subsurface soil, 6⅔ to 20 inches, is a light brownish yellow to grayish yellow sandy loam containing about .9 percent of organic matter.

The subsoil is a reddish to grayish sand, usually much coarser than that of the surface. Sometimes this stratum contains a layer of grayish clay or a mixture of clay and sand.

Management.—The topography of this type prevents its being used to any extent for agricultural purposes other than pasturing. Even for this purpose it may be improved to a considerable extent by applications of limestone and rock phosphate. The soil is somewhat acid, and an application of 2 or 3 tons of limestone per acre should be made. The phosphorus content is very low, being only about 450 pounds per acre in the plowed soil, and in the subsurface and subsoil even less. Finely ground rock phosphate should be applied in amounts of about one-half to one ton per acre until the present phosphorus content in the surface soil is well built up. Acid phosphate may be used satisfactorily. The nitrogen content is low, amounting only to about 1,600 pounds per acre. To correct this condition, legumes should be grown and turned under, together with crop residues and farm manure.

(c) TERRACE SOILS

Terrace soils usually occur along streams. They were formed at a time when the streams, owing to melting glacier ice, were much larger than they are at present, and carried large amounts of coarse material, such as sand and gravel. Upon any decrease in their velocity, these overloaded streams deposited debris along their courses. This resulted in the partial filling of the valley and the formation of what are now the terraces, bench lands, or second bottom lands. Finer material later deposited over this sand and gravel forms the present soil. When the streams become reduced to their normal size after the glacier had melted, they began cutting down thru this deposit, and the beds of the streams are now so low that the terraces, or benches, do not overflow.

In Adams county, as a rule, the deposit of gravel or sand usually found in terraces is comparatively thin. It may be covered so deep by fine material (4 to 8 feet) as to have but little effect on drainage. The value of some terrace soils, however, is impaired by the nearness of the gravel to the surface, in which case the soil is unable to resist drouth. This difficulty, however, does not exist in Adams county. The total area of terrace lands in the county is only 4.05 square miles, or .47 percent of the area of the county.

Brown Silt Loam (1526)

The terrace brown silt loam occupies only .18 square miles, or 115 acres. It is found along Mill creek. The topography is slightly undulating.

The surface soil, 0 to 6⅔ inches, is a brown silt loam differing but little, except in origin, from that of the upland. It contains about 3.4 percent of organic matter, or 34 tons per acre.

The natural subsurface extends from a depth of 6⅔ to about 17 inches. It is a brown silt loam, becoming lighter in color with increasing depth. The stratum sampled (6⅔ to 20 inches) contains about 2.1 percent of organic matter, or 42 tons per acre.

The subsoil varies from a yellow clayey silt to a yellow silt. It is friable and porous, and contains about 1.1 percent of organic matter.

Management.—This type is practically the same as the upland brown silt loam (226 and 526) in its limestone, organic-matter, and phosphorus requirements and should be managed in essentially the same manner.

Brown Sandy Loam (1560)

The terrace brown sandy loam occurs in the Mississippi bottoms in Township 3 South, Range 8 West, and comprizes an area of 493 acres. It is elevated from 20 to 25 feet above the ordinary bottom land of the Mississippi. It is slightly undulating, as a result perhaps of wind action.

The surface soil, 0 to 6⅔ inches, is a brown sandy loam containing some coarse sand and fine gravel. The organic-matter content is about .9 percent, or only 9 tons per acre.

The subsurface soil, 6⅔ to 20 inches, is a brown sandy loam containing coarse sand and fine gravel. It differs from the surface soil in that it has slightly more organic matter (a content of 1 percent). This condition occasionally

occurs in sandy loams; there is a downward leaching of plant food from the surface to the subsurface, and consequently there is a greater accumulation of plant roots in the subsurface.

The subsoil is coarser than the subsurface stratum, containing more fine gravel. It is of a yellowish color.

Management.—About the only factor to be considered in the management of this soil for the present is the need of organic matter and nitrogen. In order to supply these elements, it may be necessary to apply limestone so that legumes may be grown more satisfactorily. After limestone is applied, alfalfa ought to grow well. A good supply of organic matter will tend to improve this soil in its power to retain moisture and will also prevent the sand particles from being so readily shifted by the wind.

Brown-Gray Silt Loam on Tight Clay (1528)

Brown-gray silt loam on tight clay occurs in a few small areas, the largest being along Mill creek. The total area amounts to but 128 acres. The topography is flat to slightly undulating.

The surface soil, 0 to 6⅔ inches, is a brown or grayish brown silt loam containing a small amount of sand. The organic-matter content is about 1.5 percent, or 15 tons per acre.

The subsurface soil, 6⅔ to 20 inches, is a gray to yellowish gray silt loam. It contains about 1.1 percent of organic matter.

The subsoil, 20 to 40 inches, varies from an ordinary gray silt to a clayey silt, becoming more clayey at a depth of 36 to 38 inches. The subsoil is not so compact and impervious as is the subsoil of the same type as it occurs in the upland.

Management.—This type in general is fairly well drained, but it is low in nearly all the elements of plant food. It therefore needs to be increased in organic matter and nitrogen, and for this purpose crop residues, farm manure, and legumes should be turned under. However, before the best results can be secured with clovers, it will be necessary to apply 2 to 3 tons of limestone per acre. Phosphorus should be applied at the rate of about one-half ton of finely ground rock phosphate per acre every four or five years. If this course is followed, a system will be established which in a few years will result in the growing of better crops and, at the same time, will put the soil in better tilth.

Yellow-Gray Silt Loam (1534)

Yellow-gray silt loam is found along Bear and Mill creeks. The individual areas are not large, but the total area amounts to 1,395 acres, or .26 percent of the area of the county. The topography is flat to undulating.

The surface soil, 0 to 6⅔ inches, is a gray to yellowish gray silt loam containing a perceptible amount of fine sand. It contains approximately 1.7 percent of organic matter.

The subsurface soil, 6⅔ to 20 inches, varies from a gray to a light gray silt loam. It contains about 1 percent of organic matter.

The subsoil, 20 to 40 inches, is a gray silt, changing to a silty clay at 22 to 24 inches.

Management.—The first requirement in the improvement of this soil is the application of 2 to 4 tons of limestone per acre. This should be followed by the incorporation of crop residues and barnyard manure, and by the growing of legumes. The legumes should not be removed from the land entirely, but should either be turned under or the manure produced from them should be saved and applied to the soil. Legumes are especially well adapted for benefiting this soil because of the fact that the roots will open up the subsoil and increase the facilities for drainage. Sweet clover is more desirable than any other legume except perhaps alfalfa. After a good crop of sweet clover has been grown, there will be little difficulty in getting alfalfa to take hold. The nitrogen content is only about 1,700 pounds per acre in the plowed soil, which is too low for a good productive soil, but the growing of legumes and the turning under of other forms of organic matter will soon increase the nitrogen content sufficiently. It would be well to apply a half-ton of rock phosphate per acre every four or five years for a number of rotations.

Yellow-Gray Silt Loam Over Gravel (1536)

Yellow-gray silt loam over gravel occurs particularly along Mill creek in the southern part of the county. In the formation of this type sufficient gravel has been deposited to furnish satisfactory drainage. The total area of the type is only 397 acres.

The surface soil, 0 to 6⅔ inches, varies from a light brown to a yellow-gray silt loam. It contains about 1.6 percent of organic matter, or 16 tons per acre.

The subsurface soil, 6⅔ to 20 inches, is a gray silt loam containing about .6 percent of organic matter, or 12 tons per acre.

The subsoil is a gray silt.

Management.—The drainage of this type is good. In other respects it requires essentially the same treatment as the preceding type (1534).

Yellow-Gray Sandy Loam (1564)

Only one area of yellow-gray sandy loam is found. It comprizes but 64 acres and is located in Section 10, Township 2 South, Range 8 West, along Mill creek. This type is low in all the elements of fertility and organic matter and is becoming decidedly acid. Essentially the same treatment should be applied to this soil as that recommended for yellow-gray silt loam (1534).

(d) OLD BOTTOM-LAND SOILS

The bottom lands of the state are divided into the old, or early-formed areas, and those that have been formed more recently. As a rule, the more recently formed areas have the best soil. This is especially true of those that are located in the bottom lands along the larger streams. Of the old bottom-land soils, Adams county has 65.83 square miles, classified under two types: brown-gray silt loam on tight clay (1328), and mixed loam (1354).

Brown-Gray Silt Loam on Tight Clay (1328)

Brown-gray silt loam on tight clay is found in the bottom lands of the Mississippi. It occupies a total area of 4.95 square miles, or .58 percent of the area of the county. The largest amount is in the region just south of Lima lake.

The surface soil, 0 to 6⅔ inches, is a brown or grayish brown silt loam containing about 3.1 percent of organic matter, or 31 tons per acre.

The subsurface soil, 6⅔ to 20 inches, is a brown silt loam changing at 8 to 10 inches to a gray silt loam that is somewhat impervious. It contains about 1.6 percent of organic matter.

The subsoil, 20 to 40 inches, is a gray silt with some brown iron mottlings. It contains about .4 percent of organic matter. A heavy, compact, stratum of clay occurs at a depth of about 36 inches.

Management.—The topography of this type is flat. It is therefore necessary to provide some form of drainage. The soil is of such a character that it will tile-drain fairly well. It is fairly well supplied with organic matter and nitrogen, but the present amounts must be maintained if the productiveness of the soil is to be continued. The type is becoming acid and will require the application of about 2 to 3 tons of limestone per acre in order to put it in the best condition for growing legumes. Crop residues should be turned under. It will probably not be necessary to apply phosphate at once, but a few years of cropping, especially since overflow is prevented by a levee so that there can be no deposition of soil material, will soon make the application of phosphorus necessary.

Mixed Loam (1354)

Mixed loam occurs along the small streams in the upland as narrow strips of bottom land which rarely exceed 100 rods in width. They are subject to frequent overflow but the water does not stay on long. Usually a large amount of sediment is carried, which is deposited to a greater or less extent over the flood plain. New channels are frequently developed, thus giving the type a slightly undulating topography. The soil varies widely, and for this reason it is impossible to separate it into distinct types based on physical composition. The total area in the county is 60.88 square miles, or 7.18 percent of the area of the county.

The surface soil, 0 to 6⅔ inches, varies from a sand to a brown silt loam, or even to a brown clayey silt loam. The next flood may entirely change the character of the soil, and it is therefore impossible to make a satisfactory classification, even on a very large scale. The organic-matter content of the sample taken was about 2.4 percent, or 24 tons per acre.

The subsurface soil, 6⅔ to 20 inches, is a brown mixed loam, varying in about the same way as the surface soil. It contains, as sampled, about 1.8 percent of organic matter.

The subsoil, 20 to 40 inches, varies from a brown or yellowish sand to a sandy silt loam. The subsoil presents as great or even greater variations than does the subsurface.

Management.—The type in general is kept fairly well supplied by overflow with the elements of plant food; about the only requirement that need be considered is good cultivation.

(e) LATE SWAMP AND BOTTOM-LAND SOILS

Six types of soil constitute the group designated as the late swamp and bottom lands. They occupy, all told, an area of 82.83 square miles, or nearly 10 percent of the area of the county.

Brown Silt Loam (1426)

The brown silt loam of the Mississippi bottoms (in which is included practically all of this type) is distributed along the length of the county inside of the levee. The topography is flat to slightly undulating. The total area in the county is 33.95 square miles.

The surface soil, 0 to 6⅔ inches, varies from a light brown to a dark brown silt loam. It frequently contains some fine sand that has been derived from the wind-blown material washed down from the upland. The organic-matter content is about 2.4 percent, or 24 tons per acre.

The subsurface soil, 6⅔ to 20 inches, is a light to very dark brown silt loam containing fine sand. It has an organic-matter content of 1.9 percent, or 38 tons per acre.

The subsoil, 20 to 40 inches, varies from a yellow to a brown silt loam, often containing more organic matter than either of the other strata. This is due to the fact that material has been deposited upon and has buried an old soil rich in organic matter. This condition is found especially when the type occurs near the bluff or near a stream from the bluff.

Management.—One of the greatest difficulties in the management of this type is to prevent overflow. Levees have been built along the Mississippi and along the larger streams from the upland, such as Bear, Mill, and Rock creeks. Even at the best, however, a levee will break occasionally and cause an overflow. The type is fairly well supplied with the elements of plant food; and as long as overflow continued, the deposits were sufficient to replace the plant food removed by cropping. Since this source of plant food no longer exists, it may be necessary in the course of time to begin the application of plant-food materials. The organic-matter content is not very high; and with its constant removal thru decomposition, steps should be taken looking to its maintenance and possibly to its increase. For this purpose, crop residues, farm manure, and legumes should be plowed under. This will increase the amount of organic matter, and so improve the tilth, and will increase also the amount of nitrogen. The phosphorus content, too, is rather low, and the application of that element will become necessary in time. By applying a half-ton of finely ground rock phosphate every four or five years, the phosphorus supply will be not only maintained but actually increased. The soil is becoming very low in limestone, and acidity is developing. Ground limestone should be applied in amounts depending upon the amount of acidity present.

Brown Sandy Loam (1460)

Brown sandy loam is distributed generally thruout the Mississippi bottom land. It covers an area of 6.54 square miles, or .77 percent of the area of the county. In topography it is flat to very slightly undulating.

The surface soil, 0 to 6⅔ inches, is a brown sandy loam with varying amounts of sand and organic matter, the latter averaging about .9 percent, or 9 tons per acre.

The subsurface soil, 6⅔ to 20 inches, is a brown sandy loam containing about .8 percent of organic matter.

The subsoil, 20 to 40 inches, is a slightly loamy yellow sand, mostly medium in grade.

Management.—The amount of sand in this type is sufficient to keep the soil in good workable condition. The organic-matter content is very low, which means also a low nitrogen content. The analyses show that this soil contains only about 1,200 pounds of nitrogen per acre in the surface stratum, which is far too low for a good, productive soil. In order to increase the content of organic-matter and nitrogen and to provide better physical conditions, legumes, farm manure, and crop residues should be turned under. The soil is becoming somewhat acid, and it may be necessary to apply 1 or 2 tons of crushed limestone per acre in order to get best results with clovers. The phosphorus content in the plowed soil is about 900 pounds per acre, which is probably sufficient for producing good crops on a soil of this texture. However, there is no question but that in a short time it will be necessary to apply phosphorus in some form. Probably the most economical form in which to apply it is that of finely ground raw rock phosphate; about one-half ton per acre should be applied in each rotation for several rotations.

Drab Clay (1415)

Drab clay is well distributed in the Mississippi bottoms, usually occurring some distance back from the river. It has been formed where there has been very little current, so that only the finest material has been carried in and deposited. The topography is flat. The formation taking place at present in Lima lake probably represents the method of formation of this type, altho such extensive lakes probably did not exist at the time this particular type was being formed. The total area of drab clay in the county is 8.68 square miles, or 1.02 percent of the area of the county.

The surface soil, 0 to 6⅔ inches, is a dark brown to light drab clay. It varies in physical composition, especially in the amount of sand present. Where this sand occurs in areas of sufficient size, it is mapped as sandy drab clay loam. The surface soil contains 3.1 percent of organic matter, or 31 tons per acre.

The subsurface soil, 6⅔ to 20 inches, is a drab clay, becoming slightly lighter in color with increasing depth. It varies in somewhat the same way as does the surface. It contains about 1.8 percent of organic matter, or 36 tons per acre.

The subsoil, 20 to 40 inches, is a drab clay. It contains about 1 percent of organic matter.

Management.—The great difficulty in the management of this type is found in its tendency to form clods, as a result of puddling. Fortunately, however, it possesses the property of granulation, without which cultivation would be practically impossible. Frequently when the land is plowed, it is cloddy, and a shower followed by drying will develop granulation, or the formation of crumbs, or, as it is frequently expressed, the soil "slakes." If the soil is worked at this time, it becomes mellow and is easily put into fine condition. The presence of limestone and organic matter aid in the process of granulation. A sufficient supply of these materials should be maintained for that purpose, as well as for their other beneficial effects. To furnish the requisite organic matter, crop residues and legumes should be turned under. This soil is fairly well supplied with the elements of plant food, altho the amount of nitrogen could well be increased. It is desirable that thoro cultivation be practiced in order to stimulate the process of nitrification, or the formation of available nitrates for the crop. Another essential factor calling for consideration in the management of this type is drainage. As a rule, this type in Adams county drains well, the only great difficulty being the securing of an outlet. Thru the process of checking or cracking, passage ways are developed in the soil which permit the ready movement of water. It would, however, be beneficial to the soil if deep-rooting legumes were grown. These would not only give a larger supply of nitrogen but would also open up the soil to a greater depth. The soil is becoming somewhat acid, and it may be necessary to apply 1 or 2 tons of limestone per acre in order to secure best results with legumes.

Drab Clay Loam (1421)

Drab clay loam is rather closely associated with drab clay and often grades into that type. It embraces 15.96 square miles or 1.88 percent of the total area of the county. Its origin is practically the same as that of the preceding type.

The surface soil, 0 to 6⅔ inches, is a light brown to a drab clay loam, varying toward a sandy phase on the one hand and toward a drab clay on the other. It contains about 3.3 percent of organic matter, or 33 tons per acre.

The subsurface soil, 6⅔ to 20 inches, is a brown to drab heavy clay loam. It contains approximately 2.1 percent of organic matter, or 42 tons per acre.

The subsoil, 20 to 40 inches, varies in color from light to dark drab and in texture from a clayey silt to a silty clay.

Management.—This type is a little better provided with nitrogen and phosphorus than the drab clay, but its management should be about the same as for that type. It is becoming acid and in a few years, if not at the present time, the application of a ton or two of limestone per acre will be necessary in order to get the best results with legumes. This is especially true since the building of the levees, which have largely prevented overflow. Good cultivation is essential for this type also. The property of granulation is very desirable and should be encouraged by good drainage and the supplying of limestone and organic matter.

Sandy Drab Clay Loam (1421.1)

Sandy drab clay loam occurs in a few small areas in different parts of the Mississippi bottom land. The total area covered is 192 acres. It passes into drab clay loam (1421).

The surface soil, 0 to 6⅔ inches, is a dark drab sandy clay loam containing about 4.6 percent of organic matter, or 46 tons per acre.

The subsurface soil, 6⅔ to 20 inches, is also a dark drab sandy clay loam with the sand distributed somewhat in strata, indicating perhaps the effect of different periods of overflow. This subsurface stratum contains about 2 percent of organic matter.

The subsoil is very similar in character to the subsurface.

Management.—The management as discussed for the two preceding types will apply here also.

Mixed Loam (1454)

Mixed loam is found in the Mississippi bottoms and comprizes the area outside of the levee. It is of very little importance agriculturally, except on part of Long island, which is under cultivation. There is always danger of overflow, and whenever this occurs changes are produced in the character of the soil. At one time the soil deposited may be a heavy clay, while at other times in the same region it may be almost pure sand. The total area of this type is 17.40 square miles, or 2.05 percent of the area of the county.

The type is usually well supplied with plant food. Altho it is not very high in food elements, yet the deposit of new material from overflow is sufficient to maintain the supply of plant food indefinitely.

APPENDIX

EXPLANATIONS FOR INTERPRETING THE SOIL SURVEY

CLASSIFICATION OF SOILS

In order to intelligently interpret the soil maps, the reader must understand something of the method of soil classification upon which the survey is based. Without going far into details the following paragraphs are intended to furnish a brief explanation of the general plan of classification here used.

The unit in the soil survey is the soil type, and each type possesses more or less definite characteristics. The line of separation between adjoining types is usually distinct, altho sometimes one type grades into another so gradually that it is very difficult to draw the line between them. In such exceptional cases, some slight variation in the location of soil-type boundaries is unavoidable.

In establishing soil types several factors must be taken into account. These are: (1) the geological origin of the soil, whether residual, cumulose, glacial, eolial, alluvial, or colluvial; (2) the topography, or lay of the land; (3) the native vegetation, as prairie grasses or forest; (4) the depth and the character of the surface, the subsurface, and the subsoil, as to the percentages of gravel, sand, silt, clay, and organic matter which they contain, their porosity, granulation, friability, plasticity, color, etc.; (5) the natural drainage; (6) the agricultural value, based upon its natural productiveness; (7) the ultimate chemical composition and reaction.

Great Soil Areas in Illinois.—On the basis of the first of the above mentioned factors, namely, the geological origin, the state of Illinois has been divided into seventeen great soil areas with respect to their geological formation. The names of these areas are given in the following list along with their corresponding index numbers, the use of which is explained below. For the location of these geological areas, the reader is referred to the general map published in Bulletins 123 and 193.

000 *Residual,* soils formed in place thru disintegration of rocks, and also rock outcrop
100 *Unglaciated,* comprizing three areas, the largest being in the south end of the state
200 *Illinoisan moraines,* including the moraines of the Illinoisan glaciations
300 *Lower Illinoisan glaciation,* covering nearly the south third of the state
400 *Middle Illinoisan glaciation,* covering about a dozen counties in the west-central part of the state
500 *Upper Illinoisan glaciation,* covering about fourteen counties northwest of the middle Illinoisan glaciation
600 *Pre-Iowan glaciation,* but now believed to be part of the upper Illinoisan
700 *Iowan glaciation,* lying in the central northern end of the state
800 *Deep loess areas,* including a zone a few miles wide along the Wabash, Illinois, and Mississippi rivers
900 *Early Wisconsin moraines,* including the moraines of the early Wisconsin glaciation
1000 *Late Wisconsin moraines,* including the moraines of the late Wisconsin glaciation
1100 *Early Wisconsin glaciation,* covering the greater part of the northeast quarter of the state
1200 *Late Wisconsin glaciation,* lying in the northeast corner of the state
1300 *Old river-bottom and swamp lands,* found in the older or Illinoisan glaciation
1400 *Late river-bottom and swamp lands,* those of the Wisconsin and Iowan glaciations
1500 *Terraces,* bench or second bottom lands, and gravel outwash plains
1600 *Lacustrine deposits,* formed by Lake Chicago, the enlarged glacial Lake Michigan

Mechanical Composition of Soils.—The mechanical composition, or the texture, is a most important feature in characterizing a soil. The texture depends upon the relative proportions of the following physical constituents:

Organic matter: undecomposed and partially decayed vegetable material
Inorganic matter: clay, silt, fine sand, sand, gravel, stones

Classes of Soils.—Based upon the relative proportion of the various constituents mentioned above, soils may be grouped into a number of well recognized classes. Following is a list of these classes, arranged according to their index numbers, the use of which is explained below:

Index Number Limits	Class Names
0 to 9	Peats
10 to 12	Peaty loams
13 to 14	Mucks
15 to 19	Clays
20 to 24	Clay loams
25 to 49	Silt loams
50 to 59	Loams
60 to 79	Sandy loams
80 to 89	Sands
90 to 94	Gravelly loams
95 to 97	Gravels
98	Stony loams
99	Rock outcrop

Naming and Numbering Soil Types.—The naming of soil types has been the subject of much discussion, and practice varies considerably in this matter. In this soil survey of Illinois a system of classification and naming has been adopted which is based upon the various considerations presented in the preceding paragraphs.

After texture, one of the most striking characteristics of a soil is the color. Therefore, in the naming of soils in Illinois, a combination of color and texture, together with other descriptive terms when necessary, has been adopted so that the name in itself carries a definite description of a given soil type; as for example, "gray silt loam on tight clay," or "brown silt loam over gravel." The use of the prepositions *on* and *over* serves to indicate the presence of certain substrata. When the surface soil is underlain with material such as sand, gravel, or rock, the word *over* is used if this material lies at a depth greater than 30 inches; if it is less than 30 inches, the word *on* is used.

For further identification of soil types a system of numbering, resembling somewhat the Dewey library system, has been adopted whereby each soil type is assigned a certain number. This number indicates at once the geological origin of the soil as well as its physical description. The digits of the order of hundreds represent the geological area where the soil is found, beginning with 000, the residual, followed by 100, the unglaciated, and the rest of the series in the order of the enumeration presented in the paragraph above headed *Great Soil Areas in Illinois*. The digits of the orders of units and tens represent the various kinds of soil such as are enumerated above in the list of soil classes. Certain modifications are designated in this system by a figure placed at the right of the decimal point. To illustrate the working of this numbering system, suppose a soil type bears the number 726.5. The number 7 indicates that this soil occurs in the Iowan glaciation, the 26 that it is a brown silt loam, and the .5 that rock

is found less than 30 inches below the surface. These numbers are especially useful in designating small areas on the map and as a check in reading the colors.

A complete list of the soil types occurring in each county, along with their corresponding type numbers and the area covered by each type, will be found in the respective county soil reports.

SOIL SURVEY METHODS

Mapping the Soil Types.—In conducting the soil survey, the county constitutes the unit of working area. In order that the survey be thoroly trustworthy it is necessary that careful, well-trained men be employed to do the mapping. The work is prosecuted to the best advantage by working in parties of from two to four. Only such men are placed in charge of these parties as are thoroly experienced in the work and have shown themselves to be especially well qualified in training and ability.

The men must be able to keep their location exactly and to recognize the different soil types, with their principal variations and limits, and they must show these upon the maps correctly. A definite system is employed in checking up this work. As an illustration, one man will survey and map a strip 80 rods or 160 rods wide and any convenient length, while his associate will work independently on another strip adjoining this area, and if the work is correctly done the soil-type boundaries will match up on the line between the two strips.

An accurate base map for field use is absolutely necessary for soil mapping. The base maps are prepared on a scale of one inch to the mile, the official data of the original or subsequent land survey being used as a basis in their construction. Each surveyor is provided with one of these base maps, which he carries with him in the field; and the soil-type boundaries, together with the streams, roads, railroads, canals, and town sites are placed in their proper locations upon the map while the mapper is on the area. Each section, or square mile, is divided into 40-acre plots on the map, and the surveyor must inspect every ten acres and determine the type or types of soil thereon. The different types are indicated on the map by different colors, pencils for this purpose being carried in the field.

A small auger 40 inches long forms for each man an invaluable tool with which he can quickly secure samples of the different strata for inspection. An extension for making the auger 80 inches long is taken by each party, so that any peculiarity of the deeper subsoil layers may be studied. Each man carries a compass to aid in keeping directions. Distances along roads are measured by a speedometer or by some other measuring device, while distances in the field away from the roads are determined by pacing, an art in which the men become expert by practice. The soil boundaries can thus be located with as high a degree of accuracy as can be indicated by pencil on the scale of one inch to the mile.

Sampling for Analysis.—After all the soil types of a county have been located and mapped, samples representative of the different types are collected for chemical analysis. For this purpose usually three strata are sampled; namely, the surface (0 to 6⅔ inches), the subsurface (6⅔ to 20 inches), and the subsoil

(20 to 40 inches). These strata correspond approximately, in the common kinds of soil, to 2,000,000 pounds of dry soil per acre in the surface layer, and to two times and three times this quantity in the subsurface and the subsoil, respectively. This is, of course, a purely arbitrary division, very useful in arriving at a knowledge of the quantity and the distribution of plant food in the soil, but it should be noted that these strata do not necessarily coincide with the natural strata as they actually exist in the soil, and which are referred to in describing the soil types.

By this system of sampling we have represented separately three zones for plant feeding. The surface layer includes at least as much soil as is ordinarily turned with the plow. This is the part with which the farm manure, limestone, phosphate, or other fertilizer applied in soil improvement is incorporated, and which must be depended upon in large part to furnish the necessary plant food for the production of crops. A rich subsoil has little or no value if it lies beneath a worn-out surface, but if the fertility of the surface soil is maintained at a high point, then the strong vigorous plants will have power to secure more plant food from the subsurface and subsoil.

PRINCIPLES OF SOIL FERTILITY

Probably no agricultural fact is more generally known by farmers and landowners than that soils differ in productive power. Even tho plowed alike and at the same time, prepared the same way, planted the same day with the same kind of seed, and cultivated alike, watered by the same rains and warmed by the same sun, nevertheless the best acre may produce twice as large a crop as the poorest acre on the same farm, if not, indeed, in the same field; and the fact should be repeated and emphasized that with the normal rainfall of Illinois the productive power of the land depends primarily upon the stock of plant food contained in the soil and upon the rate at which it is liberated, just as the success of the merchant depends primarily upon his stock of goods and the rapidity of sales. In both cases the stock of any commodity must be increased or renewed whenever the supply of such commodity becomes so depleted as to limit the success of the business, whether on the farm or in the store.

CROP REQUIREMENTS

Ten different elements of plant food are essential for the growth and formation of every plant. These elements are: *carbon, oxygen, hydrogen, nitrogen, phosphorus, sulfur, potassium, magnesium, calcium, and iron;* and they are represented by the chemical symbols: C, O, H, N, P, S, K, Mg, Ca, and Fe. Some seasons in central Illinois are sufficiently favorable to allow the production of at least 50 bushels of wheat per acre, 100 bushels of corn, 100 bushels of oats, and 4 tons of clover hay. When such crops, growing under favorable climatic and cultural conditions and uninjured by disease or insect pests, are not produced the failure is due to unfavorable soil condition, which may result from poor drainage, poor physical condition, or from an actual deficiency of plant food.

Table A shows the plant-food requirements of some of our most common field crops with respect to the seven elements furnished by the soil. The figures show the weight in pounds of the various elements contained in a bushel or in a

TABLE A.—PLANT FOOD IN WHEAT, CORN, OATS, AND CLOVER

Produce		Nitrogen	Phosphorus	Sulfur	Potassium	Magnesium	Calcium	Iron
Kind	Amount							
		lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
Wheat, grain.......	1 bu.	1.42	.24	.10	.26	.08	.02	.01
Wheat, straw.......	1 ton	10.00	1.60	2.80	18.00	1.60	3.80	.60
Corn, grain........	1 bu.	1.00	.17	.08	.19	.07	.01	.01
Corn stover........	1 ton	16.00	2.00	2.42	17.33	3.33	7.00	1.60
Corn cobs.........	1 ton	4.00	.....	.....	4.00	.....	.....	.....
Oats, grain........	1 bu.	.66	.11	.06	.16	.04	.02	.01
Oat straw.........	1 ton	12.40	2.00	4.14	20.80	2.80	6.00	1.12
Clover seed.......	1 bu.	1.75	.50	.....	.75	.25	.13	.....
Clover hay........	1 ton	40.00	5.00	3.28	30.00	7.75	29.25	1.00

ton, as the case may be. From these data the amount of any element removed from an acre of land by a crop of a given yield can easily be computed.

It needs no argument to show that the continuous removal of such quantities of plant food without provision for their replacement must result sooner or later in soil depletion.

PLANT-FOOD SUPPLY

Of the ten elements of plant food, three (*carbon, oxygen,* and *hydrogen*) are secured from air and water, and seven from the soil. *Nitrogen,* one of these seven elements obtained from the soil by all plants, may also be secured from the

TABLE B.—PLANT-FOOD ELEMENTS IN MANURE, ROUGH FEEDS, AND FERTILIZERS

Material	Pounds of plant food per ton of material		
	Nitrogen	Phosphorus	Potassium
Fresh farm manure..............................	10	2	8
Corn stover....................................	16	2	17
Oat straw......................................	12	2	21
Wheat straw....................................	10	2	18
Clover hay.....................................	40	5	30
Cowpea hay.....................................	43	5	33
Alfalfa hay....................................	50	4	24
Sweet clover (water-free basis)[1]..............	80	8	28
Dried blood....................................	280	...	...
Sodium nitrate.................................	310	...	...
Ammonium sulfate...............................	400	...	...
Raw bone meal..................................	80	180	...
Steamed bone meal..............................	20	250	...
Raw rock phosphate.............................	...	250	...
Acid phosphate.................................	...	125	...
Potassium chlorid..............................	...	...	850
Potassium sulfate..............................	...	...	850
Kainit...	...	...	200
Wood ashes[2]...................................	...	10	100

[1]Young second year's growth ready to plow under as green manure.
[2]Wood ashes also contain about 1,000 pounds of lime (calcium carbonate) per ton.

air by one class of plants (legumes), in case the amount liberated from the soil is insufficient; but even these plants (which include only the clovers, peas, beans, and vetches among our common agricultural plants) are dependent upon the soil for the other six elements (*phosphorus, potassium, magnesium, calcium, iron,* and *sulfur*), and they also utilize the soil nitrogen so far as it becomes soluble and available during their period of growth.

The vast difference with respect to the supply of these essential plant food elements in different soils is well brought out in the data of the Illinois soil survey. For example, it has been found that the nitrogen in the surface 6⅔ inches, which represents the plowed stratum, varies in amount from 180 pounds per acre to nearly 33,000 pounds. In like manner the phosphorus content varies from about 420 to 4,900 pounds, the potassium ranges from 1,530 to about 58,000 pounds. Similar variations are found in all of the other essential plant food elements of the soil.

With these facts in mind it is easy to understand how a deficiency of one of these elements of plant food may become a limiting factor of crop production. When an element becomes so reduced in quantity as to become a limiting factor of production, then we must look for some outside source of supply. Table B is presented for the purpose of furnishing information regarding the quantity of plant food contained in some of the materials most commonly used as sources of plant-food supply.

LIBERATION OF PLANT FOOD

The chemical analysis of the soil gives the invoice of fertility actually present in the soil strata sampled and analyzed, but the rate of liberation is governed by many factors, some of which may be controlled by the farmer, while others are largely beyond his control. Chief among the important controllable factors which influence the liberation of plant food are the choice of crops to be grown, the use of limestone, and the incorporation of organic matter. Tillage, especially plowing, also has a considerable effect in this connection.

Feeding Power of Plants.—Different species of plants exhibit a very great diversity in their ability to obtain plant food directly from the insoluble minerals of the soil. As a class, the legumes—especially such biennial and perennial legumes as red clover, sweet clover, and alfalfa—are endowed with unusual power to assimilate from mineral sources such plant foods as calcium and phosphorus, converting them into available forms of food for the crops that follow. For this reason it is especially advantageous to employ such legumes in connection with the application of limestone and rock phosphate. Thru their growth and subsequent decay large quantities of the mineral foods are liberated for the benefit of the cereal crops which follow in the rotation, and which are less independent feeders. Moreover, as an effect of the deep rooting habit of these legumes, large quantities of mineral plant foods are brought up and rendered available from the vast reservoirs of the lower subsoil.

Effect of Limestone.—Limestone corrects the acidity of the soil and thus encourages the development not only of the nitrogen-gathering bacteria which live in the nodules on the roots of clover, cowpeas, and other legumes, but also the nitrifying bacteria, which have power to transform the insoluble and unavailable organic nitrogen into soluble and available nitrate nitrogen. At the

same time, the products of this decomposition have power to dissolve the minerals contained in the soil, such as potassium and magnesium, and also to dissolve the insoluble phosphate and limestone which may be applied in low-priced forms. Thus, in the conversion of sufficient organic nitrogen into nitrate nitrogen for a 100-bushel crop of corn, the nitrous acid formed is alone sufficient to convert seven times as much insoluble tricalcium phosphate into soluble monocalcium phosphate as would be required to supply the phosphorus for the same crop.

Organic Matter and Biological Action.—Organic matter may be supplied by animal manures, consisting of the excreta of animals and usually accompanied by more or less stable litter; and by plant manures, including green-manure crops and cover crops plowed under, and also crop residues such as stalks, straw, and chaff. The rate of decay of organic matter depends largely upon its age, condition, and origin, and it may be hastened by tillage. The chemical analysis shows correctly the total organic carbon, which constitutes, as a rule, but little more than half the organic matter; so that 20,000 pounds of organic carbon in the plowed soil of an acre corresponds to nearly 20 tons of organic matter. But this organic matter consists largely of the old organic residues that have accumulated during the past centuries because they were resistant to decay, and 2 tons of clover or cowpeas plowed under may have greater power to liberate plant food than the 20 tons of old, inactive organic matter. The history of the individual farm or field must be depended upon for information concerning recent additions of active organic matter, whether in applications of farm manure, in legume crops, or in sods of old pastures.

The condition of the organic matter of the soil is indicated to some extent by the *ratio of carbon to nitrogen.* Fresh organic matter recently incorporated with the soil contains a very much higher proportion of carbon to nitrogen than do the old resistant organic residues of the soil. The proportion of carbon to nitrogen is higher in the surface soil than in the corresponding subsoil, and in general this ratio is wider in highly productive soils well charged with active organic matter than in very old, worn soils badly in need of active organic matter.

The organic matter furnishes food for bacteria, and as it decays certain decomposition products are formed, including much carbonic acid, some nitrous acid, and various organic acids, and these acting upon the soil have the power to dissolve the essential mineral plant foods, thus furnishing soluble phosphates, nitrates, and other salts of potassium, magnesium, calcium, etc., for the use of the growing crop.

Effect of Tillage.—Tillage, or cultivation, also hastens the liberation of plant food by permitting the air to enter the soil. It should be remembered, however, that tillage is wholly destructive, in that it adds nothing whatever to the soil, but always leaves it poorer, so far as plant food is concerned. Tillage should be practiced so far as is necessary to prepare a suitable seed bed for root development and also for the purpose of killing weeds, but more than this is unnecessary and unprofitable; and it is much better actually to enrich the soil by proper applications of limestone, organic matter and other fertilizing materials, and thus promote soil conditions favorable for vigorous plant growth, than to depend upon excessive cultivation to accomplish the same object at the expense of the soil.

PERMANENT SOIL IMPROVEMENT

According to the kind of soil involved, any comprehensive plan contemplating a permanent system of agriculture will need to take into account some of the following considerations.

The Application of Limestone

The Function of Limestone.—In considering the application of limestone to land it should be understood that this material functions in several different ways, and that a beneficial result may therefore be attributable to quite diverse causes. Limestone provides the plant food calcium, of which certain crops are strong feeders. It corrects acidity of the soil, thus making for some crops a much more favorable environment as well as establishing conditions absolutely required for some of the beneficial legume bacteria. It accelerates nitrification and nitrogen fixation. It promotes sanitation of the soil by preventing the growth of certain fungus diseases, such as corn root rot. Experience indicates that it modifies either directly or indirectly the physical structure of fine-textured soils, frequently to their great improvement.

Thus, working in one or more of these different ways, limestone often becomes the key to the improvement of worn lands. Remarkable success has been experienced with limestone used in conjunction with sweet clover in the reclamation of abandoned hill land which had been ruined thru erosion.

Amounts to Apply.—If the soil is acid, usually at least 2 tons per acre of ground limestone should be applied as an initial treatment. Continue to apply limestone from time to time according to the requirement of the soil as indicated by the tests described below, or until the most favorable conditions are established for the growth of legumes, using preferably at times magnesian limestone ($CaCO_3MgCO_3$), which contains both calcium and magnesium and has slightly greater power to correct soil acidity, ton for ton, than the ordinary calcium limestone ($CaCO_3$). On strongly acid soils, or on land being prepared for alfalfa, 4 or 5 tons per acre of ground limestone may well be used for the first application.

How to Ascertain the Need for Limestone.—The need of a soil for limestone may be ascertained by applying one of the following tests for soil acidity. Along with the acidity test, a test for the presence of carbonates should be made. It should be understood that a positive test for carbonates does not guarantee the absence of acid; for it may happen, especially when the soil is near the neutral point, that positive tests for both acidity and carbonates are obtained. This condition is explained by the assumption that solid particles of calcium or magnesium carbonates form centers of alkalinity within a soil that is generally acid. Because of this fact any test made of a given soil ought to be repeated if it is to be thoroly reliable. It is also desirable to test samples from different depths. Following are the directions for making these tests:

The Litmus Paper Test for Acidity. Make a ball of fresh moist soil, break it in two, insert a piece of blue litmus paper, and press the soil firmly together. After a few minutes examine the paper. If it has turned pink or red, soil acidity is indicated. The intensity of the color and the rapidity with which it develops indicates to some extent the amount of acidity. Needless to say the reliability of the test depends upon the quality of litmus paper used.

The Potassium Thiocyanate Test for Acidity. A more recently discovered test for soil acidity which promises to be more satisfactory than the litmus test is made with a 4-percent solution of potassium thiocyanate in alcohol—4 grams of potassium thiocyanate in 100 cubic centimeters of 95-percent alcohol (not denatured). When a small quantity of soil shaken up in a test tube with this solution gives a red color the soil is acid and limestone should be applied. If the solution remains colorless the soil is not acid. The conditions for a prompt reaction require a temperature that is comfortably warm.

The Hydrochloric Acid Test for Carbonates. Make a shallow cup of a ball of soil and pour into it a few drops of concentrated hydrochloric acid. If carbonates are present they are decomposed with the liberation of carbon dioxid, which appears as gas bubbles, producing foaming or effervescence. With much carbonate present the action is lively, but with mere traces of it the bubbles are given off slowly. If no carbonate, or very little, is indicated by the test, then it is advisable to apply limestone.

The Nitrogen Problem

Nitrogen presents the greatest practical soil problem in American agriculture. Four important reasons for this are: its increasing deficiency in most soils; its cost when purchased on the open market; its removal in large amounts by crops; and its loss from soils thru leaching. Nitrogen costs from four to five times as much per pound as phosphorus. A 100-bushel crop of corn requires 150 pounds of nitrogen for its growth, but only 23 pounds of phosphorus. The loss of nitrogen from soils may vary from a few pounds to over one hundred pounds per acre, depending upon the treatment of the soil, the distribution of rainfall, and the protection afforded by growing crops.

An inexhaustible supply of nitrogen is present in the air. Above each acre of the earth's surface there are about sixty-nine million pounds of atmospheric nitrogen. The nitrogen above one square mile weighs twenty million tons, an amount sufficient to supply the entire world for four or five decades. This large supply of nitrogen in the air is the one to which the world must eventually turn.

There are two methods of collecting the inert nitrogen gas of the air and combining it into compounds that will furnish products for agricultural uses. *These are the chemical and the biological fixation of the atmospheric nitrogen.* Farmers have at their command one of these methods. By growing inoculated legumes, nitrogen may be obtained from the air, and by plowing under more than the roots of those legumes, nitrogen may be added to the soil.

Inasmuch as legumes are worth growing for feed and seed as well as for nitrate production, a considerable portion of the nitrogen thus gained may be considered a by-product. Because of that fact, it is questionable whether the chemical fixation of nitrogen, the possibilities of which now represent numerous compounds, will ever be able to replace the simple method of obtaining atmospheric nitrogen by growing inoculated legumes.

For easy figuring it may well be kept in mind that the following amounts of nitrogen are required for the produce named:

1 bushel of oats (grain and straw) requires 1 pound of nitrogen.
1 bushel of corn (grain and stalks) requires 1½ pounds of nitrogen.
1 bushel of wheat (grain and straw) requires 2 pounds of nitrogen.
1 ton of timothy contains 24 pounds of nitrogen.
1 ton of clover contains 40 pounds of nitrogen.
1 ton of cowpeas contains 43 pounds of nitrogen.
1 ton of alfalfa contains 50 pounds of nitrogen.
1 ton of average manure contains 10 pounds of nitrogen.
1 ton of young sweet clover, at about the stage of growth when it is plowed under as green manure, contains, on water-free basis, 80 pounds of nitrogen.

The roots of clover contain about half as much nitrogen as the tops, and the roots of cowpeas contain about one-tenth as much as the tops. Soils of moderate productive power will furnish as much nitrogen to clover (and two or three times as much to cowpeas) as will be left in the roots and stubble. In grain crops, such as wheat, corn, and oats, about two-thirds of the nitrogen is contained in the grain and one-third in the straw or stalks.

The Phosphorus Problem

The element phosphorus is an indispensable constituent of every living cell. It is intimately connected with the life processes of both plants and animals, the nuclear material of the cells being especially rich in this element.

The phosphorus content of a soil varies according to its origin and the kind of farming practiced. Even virgin soils are found that are deficient in phosphorus.

On all lands deficient in phosphorus (except on those susceptible to serious erosion by surface washing or gullying) that element should be applied in considerably larger amounts than are required to meet the actual needs of the crops desired to be produced. The abundant information thus far secured shows positively that finely ground natural rock phosphate can be used successfully and very profitably, and clearly indicates that this material will be the most economical form of phosphorus to use in all ordinary systems of permanent, profitable soil improvement. The first application may well be one ton per acre, and subsequently about one-half ton per acre every four or five years should be applied, at least until the phosphorus content of the plowed soil reaches 2,000 pounds per acre, which may require a total application of from 3 to 5 or 6 tons per acre of raw phosphate containing 12½ percent of the element phosphorus.

Steamed bone meal and even acid phosphate may be used in emergencies, but it should always be kept in mind that a pound of phosphorus delivered in Illinois in the form of raw phosphate (direct from the mine in carload lots), is much cheaper than the same amount in steamed bone meal or in acid phosphate, both of which cost too much per ton to permit their common purchase by farmers in carload lots, which is not the case with raw phosphate. Landowners should bear in mind the fact that phosphorus additions to the soil in amounts above the immediate crop requirements represent a permanent investment, since this element is not readily lost in the drainage water as in the case of nitrogen. It is removed from the farm thru the sale of crops, milk, and animals.

Phosphate may be applied at any time during a rotation, but it is applied to the best advantage either preceding a crop of clover, which plant seems to possess an unusual power for assimilating raw phosphate, or else at a time when it can be plowed under with some form of organic matter such as animal manure or green manure, the decay of which serves to liberate the phosphorus from its insoluble condition in the rock. It is important that the finely ground rock phosphate be intimately mixed with the organic material as it is plowed under.

The Potassium Problem

Normal soils, in which clay and silt form a considerable part of the constituency, are well stocked with potassium, altho it exists largely in insoluble

form. Such soils as sands and peats, however, are likely to be low in this element. On such soils this deficiency may be supplied by the application of some potassium salt, such as potassium sulfate, potassium chlorid, kainit, or other potassium compound, and in many instances this is done at great profit.

From all the facts at hand it seems, so far as our great areas of normal soils are concerned, that the potassium problem is not one of addition but of liberation. The Rothamsted records, which represent the oldest soil experiment fields in the world, show that for many years other soluble salts have had practically the same power as potassium to increase crop yields in the absence of sufficient decaying organic matter. Whether this action relates to supplying or liberating potassium for its own sake, or to the power of the soluble salt to increase the availability of phosphorus or other elements, is not known, but where much potassium is removed, as in the entire crops at Rothamsted, with no return of organic residues, probably the soluble salt functions in both ways.

Further evidence on this matter is furnished by the Illinois experiment field at Fairfield, where potassium sulfate has been compared with kainit both with and without the addition of organic matter in the form of stable manure. Both sulfate and kainit produced a substantial increase in the yield of corn, but the cheaper salt—kainit—was just as effective as the potassium sulfate, and returned some financial profit. Manure alone gave an increase similar to that produced by the potassium salts, but the salts added to the manure gave very little increase over that produced by the manure alone. This is explained in part perhaps because the potassium removed in the crops is mostly returned in the manure if properly cared for, and perhaps in larger part because the decaying organic matter helps to liberate and hold in solution other plant-food elements, especially phosphorus.

In laboratory experiments at the Illinois Experiment Station, it has been shown that potassium salts and most other soluble salts increase the solubility of the phosphorus in soil and in rock phosphate; also that the addition of glucose with rock phosphate in pot-culture experiments increases the availability of the phosphorus, as measured by plant growth, altho the glucose consists only of carbon, hydrogen, and oxygen, and thus contains no plant food of value.

In considering the conservation of potassium on the farm it should be remembered that in average live-stock farming the animals destroy two-thirds of the organic matter and retain one-fourth of the nitrogen and phosphorus from the food they consume, but that they retain less than one-tenth of the potassium; so that the actual loss of potassium in the products sold from the farm, either in grain farming or in live-stock farming, is negligible on land containing 25,000 pounds or more of potassium in the surface 6⅔ inches.

The Calcium and Magnesium Problem

When measured by the actual crop requirements for plant food, magnesium and calcium are more limited in some Illinois soils than potassium. But with these elements we must also consider the loss by leaching.

Doctor Edward Bartow and associates, of the Illinois State Water Survey, have shown that as an average of 90 analyses of Illinois well-waters drawn chiefly from glacial sands, gravels, or till, 3 million pounds of water (about the average

annual drainage per acre for Illinois) contained 11 pounds of potassium, 130 of magnesium, and 330 of calcium. These figures are very significant, and it may be stated that if the plowed soil is well supplied with the carbonates of magnesium and calcium, then a very considerable proportion of these amounts will be leached from that stratum. Thus the loss of calcium from the plowed soil of an acre at Rothamsted, England, where the soil contains plenty of limestone, has averaged more than 300 pounds a year as determined by analyzing the soil in 1865 and again in 1905. And practically the same amount of calcium was found by analyzing the Rothamsted drainage waters.

Common limestone, which is calcium carbonate ($CaCO_3$), contains, when pure, 40 percent of calcium, so that 800 pounds of limestone is equivalent to 320 pounds of calcium. Where 10 tons per acre of ground limestone was applied at Edgewood, Illinois, the average annual loss during the next ten years amounted to 790 pounds per acre. The definite data from careful investigations thus seem to indicate that where limestone is needed at least 2 tons per acre should be applied every four or five years.

It is of interest to note that thirty crops of clover of 4 tons each would require 3,510 pounds of calcium, while the most common prairie land of southern Illinois contains only 3,420 pounds of total calcium in the plowed soil of an acre. Thus limestone has a positive value on some soils for the plant food which it supplies, in addition to its value in correcting soil acidity and in improving the physical condition of the soil. Ordinary limestone (abundant in the southern and western parts of the state) contains nearly 800 pounds of calcium per ton; while a good grade of dolomitic limestone (the more common limestone of northern Illinois) contains about 400 pounds of calcium and 300 pounds of magnesium per ton. Both of these elements are furnished in readily available form in ground dolomitic limestone.

The Sulfur Question

In considering the relation of sulfur in a permanent system of soil fertility it is important to understand something of the cycle of transformations that this element undergoes in nature. Briefly stated this is as follows:

Sulfur exists in the soil in both organic and inorganic forms, the former being gradually converted to the latter form thru bacterial action. In this inorganic form sulfur is taken up by plants which in their physiological processes change it once more into an organic form as a constituent of protein. When these plant proteins are consumed by animals, the sulfur becomes a part of the animal protein. When these plant and animal proteins are decomposed, either thru bacterial action, or thru combustion, the sulfur passes into the atmosphere or into the soil solution in the form of sulfur dioxid gas. This gas unites with oxygen and water to form sulfuric acid, which is readily washed back into the soil by the rain, thus completing the cycle, from soil—to plants and animals —to air—to soil.

In this way sulfur becomes largely a self-renewing element of the soil, altho there is a considerable loss from the soil by leaching. Observations taken at the Illinois Agricultural Experiment Station show that 40 pounds of sulfur per acre are brought into the soil thru the annual rainfall. With a fair stock of

sulfur, such as exists in our common types of soil, and an annual return, which of itself would more than suffice for the needs of maximum crops, the maintenance of an adequate sulfur supply presents little reason at present for serious concern. There are regions, however, where the natural stock of sulfur in the soil is not nearly so high and where the amount returned thru rainfall is small. Under such circumstances sulfur soon becomes a limiting element of crop production, and it will be necessary sooner or later to introduce this substance from some outside source. Investigation is now under way to determine to what extent this situation may apply to conditions in Illinois.

Physical Improvement of Soils

In the management of most soil types, one very important thing, aside from proper fertilization, tillage, and drainage, is to keep the soil in good physical condition, or good tilth. The constituent most important for this purpose is organic matter. Organic matter in producing good tilth helps to control washing of soil on rolling land, raises the temperature of drained soil, increases the moisture-holding capacity of the soil, retards capillary rise and consequently loss of moisture by surface evaporation, and helps to overcome the tendency of some soils to run together badly.

The physical effect of organic matter is to produce a granulation or mellowness, by cementing the fine soil particles into crumbs or grains about as large as grains of sand, which produces a condition very favorable for tillage, percolation of rainfall, and the development of plant roots.

Organic matter is being destroyed during a large part of the year and the nitrates produced in its decomposition are used for plant growth. Altho this decomposition is necessary, it nevertheless reduces the amount of organic matter, and provision must therefore be made for maintaining the supply. The practical way to do this is to turn under the farm manure, straw, corn stalks, weeds, and all or part of the legumes produced on the farm. The amount of legumes needed depends upon the character of the soil. There are farms, especially grain farms, in nearly every community where all legumes could be turned under for several years to good advantage.

Manure should be spread upon the land as soon as possible after it is produced, for if it is allowed to lie in the barnyard several months as is so often the case, from one-third to two-thirds of the organic matter will be lost.

Straw and corn stalks should be turned under, and not burned. Probably no form of organic matter acts more beneficially in producing good tilth than corn stalks. It is true, they decay rather slowly, but it is also true that their durability in the soil is exactly what is needed in the production of good tilth. Furthermore, the nitrogen in a ton of corn stalks is one and one-half times that of a ton of manure, and a ton of dry corn stalks incorporated in the soil will ultimately furnish as much humus as four tons of average farm manure. When burned, however, both the humus-making material and the nitrogen are lost to the soil.

It is a common practice in the corn belt to pasture the corn stalks during the winter and often rather late in the spring after the frost is out of the ground. This tramping by stock sometimes puts the soil in bad condition for

working. It becomes partially puddled and will be cloddy as a result. If tramped too late in the spring, the natural agencies of freezing and thawing and wetting and drying, with the aid of ordinary tillage, fail to produce good tilth before the crop is planted. Whether the crop is corn or oats, it necessarily suffers, and if the season is dry, much damage may be done. If the field is put in corn, a poor stand is likely to result, and if put in oats, the soil is so compact as to be unfavorable for their growth. Sometimes the soil is worked when too wet. This also produces a partial puddling which is unfavorable to physical, chemical, and biological processes. The bad effect will be greater if cropping has reduced the organic matter below the amount necessary to maintain good tilth.

Systems of Crop Rotations

In a program of permanent soil improvement one should adopt at the outset a good rotation of crops, including a liberal use of legumes, in order to increase the organic matter of the soil either by plowing under the legume crops and other crop residues (straw and corn stalks), or by using for feed and bedding practically all the crops raised and returning the manure to the land with the least possible loss. No one can say in advance for every particular case what will prove to be the best rotation of crops, because of variation in farms and farmers and in prices for produce.

Following are a few suggested rotations, applicable to the corn belt, which may serve as models or outlines to be modified according to special circumstances.

Six-Year Rotations

First year —Corn
Second year —Corn
Third year —Wheat or oats (with clover, or clover and grass)
Fourth year —Clover, or clover and grass
Fifth year —Wheat (with clover), or grass and clover
Sixth year —Clover, or clover and grass

Of course there should be as many fields as there are years in the rotation. In grain farming, with small grain grown the third and fifth years, most of the unsalable products should be returned to the soil, and the clover may be clipped and left on the land or returned after threshing out the seed (only the clover seed being sold the fourth and sixth years); or, in live-stock farming, the field may be used three years for timothy and clover pasture and meadow if desired. The system may be reduced to a five-year rotation by cutting out either the second or the sixth year, and to a four-year system by omitting the fifth and sixth years, as indicated below.

Five-Year Rotations

First year —Corn
Second year —Wheat or oats (with clover, or clover and grass)
Third year —Clover, or clover and grass
Fourth year —Wheat (with clover), or clover and grass
Fifth year —Clover, or clover and grass

First year —Corn
Second year —Corn
Third year —Wheat or oats (with clover, or clover and grass)
Fourth year —Clover, or clover and grass
Fifth year —Wheat (with clover)

First year —Corn
Second year —Cowpeas or soybeans
Third year —Wheat (with clover)
Fourth year —Clover
Fifth year —Wheat (with clover)

The last rotation mentioned above allows legumes to be seeded four times. Alfalfa may be grown on a sixth field for five or six years in the combination rotation, alternating between two fields every five years, or rotating over all the fields if moved every six years.

Four-Year Rotations

First year —Wheat (with clover)
Second year —Corn
Third year —Oats (with clover)
Fourth year —Clover

First year —Corn
Second year —Corn
Third year —Wheat or oats (with clover)
Fourth year —Clover

First year —Corn
Second year —Wheat or oats (with clover)
Third year —Clover
Fourth year —Wheat (with clover)

First year —Wheat (with clover)
Second year —Clover
Third year —Corn
Fourth year —Oats (with clover)

First year —Corn
Second year —Cowpeas or soybeans
Third year —Wheat (with clover)
Fourth year —Clover

Alfalfa may be grown on a fifth field for four or eight years, which is to be alternated with one of the four; or the alfalfa may be moved every five years, and thus rotated over all five fields every twenty-five years.

Three-Year Rotations

First year —Corn
Second year —Oats or wheat (with clover)
Third year —Clover

First year —Wheat (with clover)
Second year —Corn
Third year —Cowpeas or soybeans

By allowing the clover, in the last rotation mentioned, to grow in the spring before preparing the land for corn, we have provided a system in which legumes grow on every acre every year. This is likewise true of the following suggested two-year system:

Two-Year Rotations

First year —Oats or wheat (with sweet clover)
Second year —Corn

Altho in this two-year rotation either oats or wheat is suggested, as a matter of fact, by dividing the land devoted to small grain, both of these crops can be grown simultaneously, thus providing a three-crop system in a two-year cycle.

It should be understood that in all of the above suggested cropping systems it may be desirable in some cases to substitute rye for the wheat or oats. In all of these proposed rotations the word *clover* is used in a general sense to designate either red clover, alsike clover, or sweet clover. The value of sweet clover especially as a green manure for building up depleted soils, as well as a pasture and hay-crop, is becoming thoroly established, and its importance in a crop-rotation program may well be emphasized.

SUPPLEMENT: EXPERIMENT FIELD DATA

(Results from Experiment Fields Representing the More Important Types of Soil Occurring in Adams County)

In the earlier reports of this series it was the practice to incorporate in the body of the report the results of certain experiment fields, for the purpose of illustrating the possibilities of improving the soil of various types. The information carried by such data must, naturally, be considered more or less tentative. As the fields grow older new facts develop, which in some instances may call for the modification of former recommendations. It has therefore seemed desirable to separate this experiment field data from the more permanent information of the soil survey, and embody the same in the form of a supplement to the soil report proper, thus providing a convenient arrangement for possible future revisions as additional data accumulate.

The University of Illinois has conducted altogether about fifty soil experiment fields in different sections of the state and on various types of soil. Altho some of these fields have been discontinued, the large majority are still in operation. It is the present purpose to report the summarized results from certain of these fields which are representative of the types of soil described in the accompanying soil report.

A few general explanations at this point, which apply to all the fields, will relieve the necessity of numerous repetitions in the following pages.

Size and Arrangement

These fields vary in size from less than two acres up to 40 acres or more. They are laid off into series of plots, the plots commonly being either one-fifth or one-tenth acre in area. Each series is occupied by one kind of crop. Usually there are several series so that a crop rotation can be carried on with every crop represented every year.

Farming Systems

On many of the fields the treatment provides for two distinct systems of farming, live-stock farming and grain farming.

In the live-stock system, stable manure is used to furnish organic matter and nitrogen. The amount applied to a plot is based upon the amount that can be produced from crops raised on that plot.

In the grain system no animal manure is used. The organic matter and nitrogen are applied in form of plant manures, including all the plant residues produced, such as corn stalks, straw from wheat, oats, clover, etc., along with leguminous catch crops plowed under. It is the plan in this latter system to remove from the land, in the main, only the grain and seed produced, except in the case of alfalfa, that crop being harvested for hay the same as in the live-stock system.

Crop Rotations

Crops which are of interest in the respective localities are grown in definite rotations, and on most of the fields provision is made so that every crop in the rotation is represented every year. The most common rotation used is wheat,

corn, oats, and clover; and often these crops are accompanied by alfalfa growing on a fifth series. In the grain system a legume catch crop, usually sweet clover, is included, which is seeded on the young wheat in the spring and plowed under in the fall or in the following spring in preparation for corn. In the event of clover failure, soybeans are substituted.

Soil Treatment

The treatment applied to the plots has, in large part, been standardized according to a rather definite system, altho many deviations from this system occur.

Following is a brief explanation of this standard system of treatment.

Animal Manures.—Animal manures, consisting of excreta from animals, with stable litter, are spread upon the respective plots in amounts proportionate to previous crop yields, the applications being made in the preparation for corn.

Plant Manures.—All crop residues produced on the land, such as stalks, straw, and chaff, are returned to the soil, and in addition a green-manure crop of sweet clover is seeded in small grains to be plowed under in preparation for corn. (On plots where limestone is lacking the sweet clover seldom survives.) This practice is designated as the *residues system.*

Mineral Manures.—The usual yearly acre-rates of application have been: for limestone, 1,000 pounds; for raw rock phosphate, 500 pounds; and for potassium, the equivalent of 200 pounds of kainit. The initial application of limestone has usually been 4 tons per acre.

Explanation of Symbols Used

0 = Untreated land or check plots
M = Manure (animal)
R = Residues (from crops, and includes legumes used as green manure)
L = Limestone
P = Phosphorus
K = Potassium (usually in the form of kainit)
N = Nitrogen (usually in the form contained in dried blood)
( ) = Parentheses enclosing figures signify tons of hay, as distinguished from bushels of seed

In discussions of this sort of data, financial profits or losses based upon assigned market values are frequently considered. However, in view of the erratic fluctuations in market values—especially in the past few years—it seems futile to attempt to set any prices for this purpose that are at all satisfactory. The yields are therefore presented with the thought that with these figures at hand the financial returns from a given practice can readily be computed upon the basis of any set of market values that the reader may choose to apply.

BROWN SILT LOAM

Several experiment fields have been conducted on brown silt loam soil at various locations in Illinois. Those located at the University have been in operation the longest and they serve well to illustrate the principles involved in the maintenance and improvement of this type of soil.

The Morrow Plots

It happens that the oldest soil experiment field in the United States is located on typical brown silt loam of the early Wisconsin glaciation, on the campus of the University of Illinois. This field was started in 1879 by George E. Morrow, who for many years was Professor of Agriculture, and these plots are known as the Morrow plots.

The Morrow series now consists of three plots divided into halves and the halves are subdivided into quarters. On one plot corn is grown continuously; on the second, corn and oats are grown in rotation; and on the third, corn, oats, and clover are rotated. The north half of each plot has had no fertilizing material applied from the beginning of the experiments, while the south half has been treated since 1904, receiving standard applications of farm manure with cover crops grown in the one-crop and two-crop systems. Phosphorus has been applied in two different forms: rock phosphate to the southwest quarter at the rate of 600 pounds, and steamed bone meal to the southeast quarter at the rate of 200 pounds per acre per year up to 1919, when the rock phosphate was increased sufficiently to bring up the total amount applied to four times the quantity of bone meal applied. At the same time the rate of subsequent application of both forms of phosphorus was reduced to one-fourth the quantity, or to 200 pounds of rock phosphate and 50 pounds of bone meal per acre per year. In 1904 ground limestone was applied at the rate of 1,700 pounds per acre to the south half of each plot, and in 1918 a further application was made at the rate of 5 tons per acre with the intention of standardizing the application to the rate of 1,000 pounds of limestone per acre per year.

Table 1 gives the yearly record of the crop yields, and Table 2 presents the same in summarized form.

FIG. 1.—CORN ON THE MORROW PLOTS IN 1910

TABLE 1.—URBANA FIELD, MORROW PLOTS: BROWN SILT LOAM; PRAIRIE; EARLY WISCONSIN GLACIATION

Crop Yields in Soil Experiments—Bushels or (tons) per acre

Years	Soil treatment applied	Corn every year	Two-year rotation		Three-year rotation		
		Corn	Corn	Oats	Corn	Oats	Clover
1879–87	None........	....	....	....	....	....	....
1888	None........	54.3	49.5	....	....	48.6	....
1889	None........	43.2	....	37.4	....	....	(4.04)
1890	None........	48.7	54.3	....	....	....	(1.51)
1891	None........	28.6	33.2	....	....	....	(1.46)
1892	None........	33.1	....	37.2	70.2	....	....
1893	None........	21.7	29.6	....	34.1	....	....
1894	None........	34.8	....	57.2	....	65.1	....
1895	None........	42.2	41.6	....	....	22.2	....
1896	None........	62.3	....	34.5	....	....	....
1897	None........	40.1	47.0	....	....	....	....
1898	None........	18.1	....	....	....	....	....
1899	None........	50.1	44.4	....	53.5	....	....
1900	None........	48.0	....	41.5	....	....	....
1901	None........	23.7	33.7	....	34.3	....	....
1902	None........	60.2	....	56.3	....	54.6	....
1903	None........	26.0	35.9	....	....	....	(1.11)
1904	None........	21.5	....	17.5	55.3	....	....
1904	MLP........	17.1	....	25.3	72.7	....	....
1905	None........	24.8	50.0	....	....	42.3	....
1905	MLP........	31.4	44.9	....	....	50.6	....
1906	None........	27.1	....	34.7	....	....	(1.42)[1]
1906	MLP........	35.8	....	52.4	....	....	(1.74)[1]
1907	None........	29.0	47.8	....	80.5	....	....
1907	MLP........	48.7	87.6	....	93.6	....	....
1908	None........	13.4	....	32.9	....	40.0	....
1908	MLP........	28.0	....	45.0	....	44.4	....
1909	None........	26.6	33.0	....	....	....	(.65)[2]
1909	MLP........	31.6	64.8	....	....	....	(1.73)[3]
1910	None........	35.9	....	33.8	58.6	....	....
1910	MLP........	54.6	....	59.4	83.3	....	....
1911	None........	21.9	28.6	....	....	20.6	....
1911	MLP........	31.5	46.3	....	....	38.0	....
1912	None........	43.2	....	55.0	....	....	16.3[1]
1912	MLP........	64.2	....	81.0	....	....	20.0[1]
1913	None........	19.4	29.2	....	33.8	....	....
1913	MLP........	32.0	25.0	....	47.8	....	....
1914	None........	31.6	....	33.6	....	39.6	....
1914	MLP........	39.4	....	58.2	....	60.4	....
1915	None........	40.0	49.0	....	....	....	24.2[1]
1915	MLP........	66.0	81.2	....	....	....	27.1[1]
1916	None........	11.2	....	37.5	27.8	....	....
1916	MLP........	10.8	....	64.7	40.6	....	....
1917	None........	40.0	48.4	....	....	68.4	....
1917	MLP........	78.0	81.4	....	....	86.9	....
1918	None........	13.6	....	27.2	....	....	(2.58)
1918	MLP........	32.6	....	59.3	....	....	(4.04)
1919	None........	24.0	30.8	....	52.2	....	....
1919	MLP........	43.4	66.2	....	70.8	....	....
1920	None........	28.2	....	37.2	....	52.2	....
1920	MLP........	54.4	....	51.6	....	69.7	....
1921	None........	19.8	30.6	....	....	....	(.26)[4]
1921	MLP........	42.2	63.4	...	....	....	(1.33)[5]

[1]Soybeans.
[2]In addition to the hay, .64 bushel of seed was harvested.
[3]In addition to the hay, 1.17 bushels of seed were harvested.
[4]In addition to the hay, .53 bushel of seed was harvested.
[5]In addition to the hay, .85 bushel of seed was harvested.

TABLE 2.—URBANA FIELD, MORROW PLOTS: GENERAL SUMMARY
Average Annual Yields—Bushels or (tons) per acre

Years	Soil treatment applied	Corn every year	Two-year rotation		Three-year rotation		
			Corn	Oats	Corn	Oats	Clover
		16 crops	*9 crops*	*6 crops*	*4 crops*	*4 crops*	*4 crops*
1888 to 1903	None........	39.7	41.0	44.0	48.0	47.6	(2.03)
		18 crops	*9 crops*	*9 crops*	*6 crops*	*6 crops*	*4 crops*
1904 to 1921	None........	26.2	38.6	34.4	51.4	43.9	(1.23)[1]
	MLP........	41.2	62.9	55.2	68.1	58.3	(2.21)[1]

[1]One crop of soybean hay.

Summarizing the data from these Morrow plots into two periods with the second period beginning in 1904 when the treatment began on the half-plots, some interesting comparisons may be made. In the first place we find in the continuous corn plot a marked decrease in the second period in the average yield of corn, amounting to one-third of the crop. In the two-year rotation there is a decrease in both corn and oats production, while the averages for the three-year system show an increase in corn yield and decreases in oats and clover. Unfortunately the numbers of crops included in these last averages are too small to warrant positive conclusions.

The increase brought about by soil treatment stands out in all cases, showing the possibility not only of restoring but also of greatly improving the productive power of this land that has been so abused by continuous cropping without fertilization.

The Davenport Plots

Another set of plots on the University campus at Urbana, forming a more extensive series than the Morrow plots, but of more recent origin, are the Davenport plots. Here each crop in the rotation is represented every year. These plots were laid out in 1895, but special soil treatment was not begun until 1901. They now comprize five series of ten plots each, and each series constitutes a "field" in a crop rotation system.

From 1901 to 1911 three of the series were in a three-year rotation system of corn, oats, and clover, while the remaining two series rotated in corn and oats. In 1911 these two systems were combined into a five-series field, with a crop rotation of wheat, corn, oats, and clover, with alfalfa on a fifth field. The alfalfa occupies one series during a rotation of the other four crops, shifting to another series in the fifth year, thus completing the cycle of all series in twenty-five years.

The soil treatment applied to these plots has been as follows:

Legume cover crops were seeded in the corn at the last cultivation on Plots 2, 4, 6, and 8, from 1902 to 1907, but the growth was small and the effect, if any, was to decrease the returns from the regular crops. Crop residues (**R**) have been returned to these same plots since 1907. These consist of stalks and straw, and all legumes except alfalfa hay and the seed of clover and soybeans. Beginning in 1918 a modification of the practice was made in that one cutting of the red clover crop is harvested as hay. In conjunction with these residues a catch crop of sweet clover grown with the wheat is plowed under.

Manure (**M**) was applied preceding corn, at the rate of 2 tons per acre per year in 1905, 1906, and 1907; subsequently as many tons have been applied as there have been tons of air-dry produce harvested from the respective plots.

Lime (**L**) was applied on Plots 4 to 10 at the rate per acre of 250 pounds of air-slaked lime in 1902, and 600 pounds of limestone in 1903. No further application was made until 1911, when the system of cropping was changed. Since that time applications of limestone have been made at the rate of one-half ton per acre per year.

Phosphorus (**P**) was applied on Plots 6 to 9 at the rate of 25 pounds per acre per annum in 200 pounds of steamed bone meal; but beginning with 1908 rock phosphate at the rate of 600 pounds per acre per annum was substituted for the bone meal on the west half of each of these plots. These applications continued until 1918 when adjustments were begun, first to make the rate of application of rock phosphate four times that of the bone meal, and finally to reduce the amounts of these materials to 200 pounds of rock phosphate and 50 pounds of bone meal per acre per annum. The usual practice has been to apply and plow under at one time all phosphorus and potassium required for the rotation.

Potassium (**K** = kalium) has been applied on Plots 8 and 9, in connection with the organic manures and phosphorus, at the yearly rate of 42 pounds per acre, and mainly as potassium sulfate.

On Plot 10 about five times as much manure and phosphorus are applied as on the other plots, but this "extra heavy" treatment was not begun until 1906, only the usual amounts of lime, phosphorus, and potassium having been applied in previous years. The purpose in making these heavy applications is to try to determine the climatic possibilities in crop yields by removing the limitations of inadequate fertility.

It will be observed that the applications mentioned above provide for the two rather distinct systems of farming already described. *The grain system,* in which animal manure is not produced and where the organic matter is provided by the direct return to the soil of all crop residues along with legumes, is exemplified in Plots 2, 4, 6, and 8; and the *live-stock system,* in which farm manure is utilized for soil enrichment, is represented in Plots 3, 5, 7, and 9.

Table 3 shows a summary of the results obtained on the Davenport plots beginning with the year 1911, when the present cropping system was introduced.

When used in conjunction with phosphorus the crop residues and the manure appear about equally effective; but where phosphorus is not applied, the manure has been decidedly more effective, under the conditions of the experiment. It should be observed, however, in this connection, that the plowing under of clover is a very essential feature of the residues system, and that, as a matter of fact, there were five clover failures, when soybeans were substituted, during the ten years. Perhaps with a more reliable biennial legume than red clover, the results would have been more favorable for this system.

By comparing Plots 2 and 3 with Plots 4 and 5, it is found that limestone has had a beneficial effect on all crops. What the financial profit amounts to depends obviously upon the market value of the crops and the cost of the limestone.

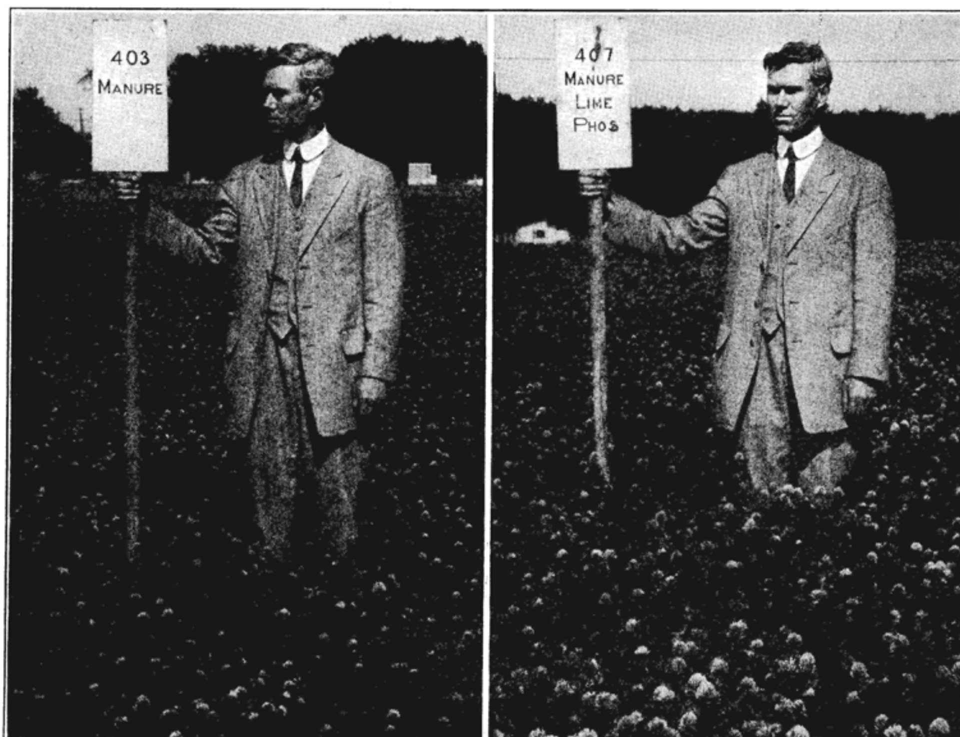
TABLE 3.—URBANA FIELD, DAVENPORT PLOTS: BROWN SILT LOAM, PRAIRIE; EARLY WISCONSIN GLACIATION

Average Annual Yields—Bushels or (tons) per acre
1911–1920

Serial plot No.	Soil treatment applied	Corn	Oats	Wheat	Clover 5 crops	Soybeans 5 crops	Alfalfa
1	0	55.6	50.5	26.0	(2.42)	(1.47)	(2.43)
2	R	57.1	52.3	28.7	1.47[1]	19.8	(2.46)
3	M	66.3	61.9	28.2	(2.56)	(1.62)	(2.52)
4	RL	64.8	55.6	31.4	1.61[1]	20.3	(2.72)
5	ML	69.6	64.1	32.8	(2.90)	(1.67)	(3.03)
6	RLP	71.5	69.8	43.0	2.29[1]	23.5	(3.69)
7	MLP	73.0	68.6	40.0	(3.52)	(1.97)	(3.76)
8	RLPK	70.9	72.5	40.7	1.79[1]	25.5	(3.77)
9	MLPK	70.2	72.0	39.2	(3.40)	(2.20)	(3.73)
10	Mx5LPx5	65.9	71.4	40.6	(3.31)	(2.22)	(3.77)

[1]In addition to the clover seed, a crop of hay was harvested one year on Plots 2, 4, 6, and 8, yielding 2.38, 2.20, 2.54, and 2.39 tons respectively.

Comparing Plots 4 and 5 with Plots 6 and 7, respectively, there is found in all cases an increase in crop yield as a result of adding phosphorus. The effect on wheat is especially pronounced. Where limestone and phosphorus are applied in addition to the crop residues, an increase of 17 bushels of wheat, over the yield of the untreated land, has been obtained as a ten-year average.



Manure
Yield: 1.43 tons per acre

Manure, limestone, phosphorus
Yield: 2.90 tons per acre

FIG. 2.—CLOVER ON THE DAVENPORT PLOTS IN 1913

The effect of adding potassium to the treatment is of much interest. Plots 8 and 9 are the same as Plots 6 and 7, respectively, except that potassium has been applied to the former. On the whole, no significant benefit is shown from the addition of potassium.

No benefit appears as the result of the extra-heavy applications of manure and phosphorus on Plot 10. In fact the corn yields are noticeably less here than on the plots receiving the normal applications of these materials.

The University South Farm

On the University South Farm, at Urbana, several series of plots devoted primarily to variety testing and other crop-production experiments are so laid out as to show the effects of certain soil treatments that have been applied. Several different systems of crop rotation are employed and the crops are so handled as to exemplify the two general systems of farming, grain and live-stock.

The summarized results presented in Table 4 represent three different systems of cropping. The first, designated as the Southwest rotation, is to be regarded as a good rotation for general practice, on this type of soil, under Illinois conditions. This is a four-field rotation of wheat, corn, oats, and clover.

TABLE 4.—URBANA FIELD, SOUTH FARM: BROWN SILT LOAM, PRAIRIE; EARLY WISCONSIN GLACIATION

Average Annual Yields—Bushels or (tons) per acre
1908-1919

Southwest Rotation: Series 100, 200, 400[1]: Wheat, Corn, Oats, Clover[2]					
Soil treatment applied[6]	Corn 9 crops	Oats[3] 9 crops	Wheat[3] 8 crops	Clover[4] 3 crops	Soybeans 7 crops
RP	62.3	51.9	41.0	1.05	17.3[5]
R	51.9	46.5	26.9	1.38	16.2[5]
M	59.7	50.2	29.1	(2.28)	(1.25)
MP	64.3	55.4	43.1	(2.86)	(1.51)
RLP	60.5	57.2	41.8	.64	16.4[5]
R	49.7	49.6	25.8	.83	14.7[5]
M	55.5	54.1	27.8	(1.71)	(1.28)
MLP	64.1	59.6	43.9	(1.77)	(1.58)
North-Central Rotation: Series 500, 600, 700[1]: Corn, Corn, Oats, Clover[2]					
Soil treatment applied[6]	Corn 1st year 9 crops	Corn 2d year 9 crops	Oats 9 crops	Clover 5 crops	Soybeans 4 crops
RP	56.7	51.1	56.1	.54	16.9
R	51.7	45.2	52.0	.50	16.0
M	54.9	46.7	52.1	(2.29)	(1.60)
MP	56.5	53.4	56.9	(2.73)	(1.74)
South-Central Rotation: Series 500, 600, 700[1]: Corn Corn, Corn, Soybeans					
Soil treatment applied[6]	Corn 1st year 9 crops	Corn 2d year 9 crops	Corn 3d year 9 crops		Soybeans 9 crops
RP	51.9	44.0	41.3		20.0
R	45.5	39.9	35.2		19.2
M	50.1	42.1	33.5		(1.59)
MP	54.5	46.7	42.0		(1.66)

[1]Results from Series 300 and 800 are omitted on account of variation in soil type.
[2]Soybeans when clover fails.
[3]Only seven crops with limestone.
[4]Only one crop with limestone.
[5]Average of five crops.
[6]All phosphorus plots received ½ ton per acre of limestone in 1903.

TABLE 5.—COMPARING PRODUCTION OF CORN IN THREE DIFFERENT ROTATION SYSTEMS
YIELDS FROM PLOTS ON THE UNIVERSITY SOUTH FARM
Twelve-Year Average (1908–1919)—Bushels per acre

Rotation	Wheat-corn-oats-legume[1]	Corn-corn-oats-legume[2]		Corn-corn-corn-legume[3]		
Treatment	Corn	1st Corn	2d Corn	1st Corn	2d Corn	3d Corn
Organic manures..............	55.8	53.3	46.0	47.8	41.0	34.3
Organic manures, phosphorus...	63.2	56.6	52.3	53.2	45.3	41.6

[1]Clover 3 crops and soybeans 7 crops.
[2]Clover 5 crops, and soybeans 5 crops.
[3]Soybeans 9 crops.

The second, or North-Central rotation, consisting of corn, corn, oats, and clover, represents a system very commonly practiced; and the third or South-Central rotation, consisting of corn, corn, corn, and soybeans, must be considered as a poor rotation from the standpoint of maintaining the productiveness of the land.

On the whole, the "residues" have not returned yields quite so high as those produced by the manure treatment; but, as remarked above in the discussion of the Davenport plots, the residues system has probably been at a disadvantage thru frequent clover failures. On the North-Central rotation, where conditions seem to have been more favorable for clover, there is very little difference between the effect of manure and of residues.

Residues plowed under
Yield: 35.2 bushels per acre

Residues and rock phosphate
Yield: 50.1 bushels per acre

FIG. 3.—WHEAT ON THE UNIVERSITY SOUTH FARM IN 1911

In the rotation system in which limestone is being applied, no benefit of consequence to any of the crops except oats appears from the use of this material. The test, however, has hardly been of sufficient duration to warrant final conclusions; and furthermore, the comparison may be somewhat impaired by a possible residual effect of the small application of limestone made in 1903 to all the phosphorus plots.

The results obtained from the use of phosphorus are important because this element has been applied to these plots solely in the form of raw rock phosphate. The figures in almost every case show an increase in yield where the phosphorus has been applied, and in most cases this increase is very pronounced. The wheat is especially responsive to phosphorus.

The records furnish some interesting comparisons of corn yields produced under different systems of cropping. Table 5 gives a general summary of the corn yields only, in which the results from the residues and manure treatments are averaged together as "organic manures." The highest annual acre-yields are found where corn occurs but once in a rotation. Where corn is grown twice in succession, the annual acre-yields are less; and where corn occurs three times, there is a further reduction. Also, the first crop of corn within a rotation produces more than the second, and the second crop yields more than the third. These are useful facts for consideration in connection with problems of general farm management.

The Clayton Field

An experiment field representing a light phase of the brown silt loam is located in Adams county just south of Clayton. This field has been in operation since 1911. The diagram presented as Fig. 4 shows the arrangement of the plots on this field.

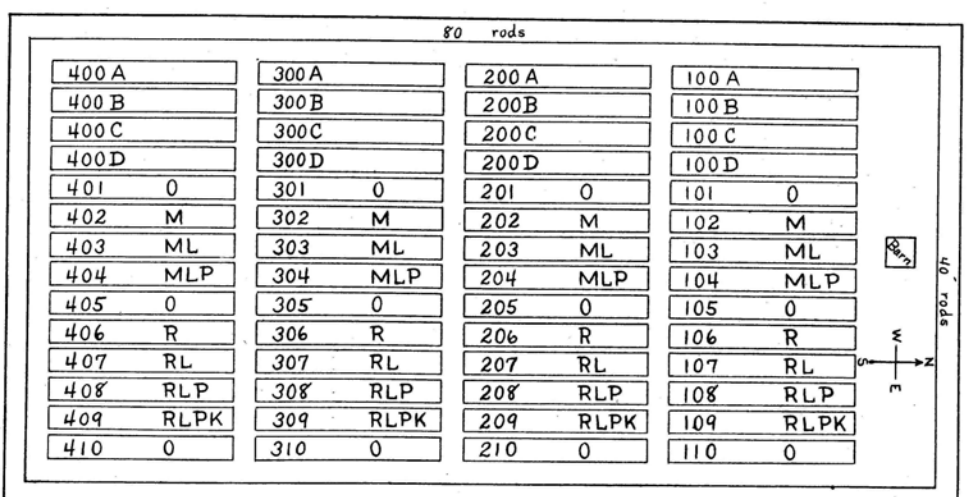


FIG. 4.—DIAGRAM SHOWING ARRANGEMENT OF PLOTS ON THE CLAYTON EXPERIMENT FIELD

TABLE 6.—CLAYTON FIELD: BROWN SILT LOAM, PRAIRIE; UPPER ILLINOISAN GLACIATION
ROTATION: WHEAT, CORN, OATS, CLOVER

Crop Yields—Bushels or (tons) per acre

Plot No.	Soil treatment applied	1911 Corn[1]	1912 Oats[2]	1913 Soybeans[5]	1914 Wheat[6]	1915 Corn	1916 Oats	1917 Clover	1918 Wheat	1919 Corn	1920 Oats	1921 Soybeans
101	0.......	45.8	43.0	10.3	5.0	23.3	19.2	(2.01)	27.3	37.7	22.3	20.1
102	M......	50.0	42.3	(1.49)	4.8	27.3	21.6	(2.51)	30.2	50.3	38.1	18.8
103	ML.....	52.4	39.3	(1.58)	5.3	28.6	20.8	(3.26)	42.8	47.9	32.8	28.1
104	MLP....	48.7	46.9	(1.50)	5.4	31.5	23.0	(3.55)	47.0	41.6	40.6	21.5
105	0.......	54.6	44.1	12.1	6.2	25.6	20.3	1.92	33.3	30.1	25.9	21.3
106	R.......	56.5	40.0	12.5	8.5	36.0	20.2	2.17	33.7	49.7	43.1	25.8
107	RL......	57.6	41.6	13.5	6.8	55.4	31.4	2.17	45.5	57.9	52.8	24.3
108	RLP....	55.5	42.3	13.0	8.8	55.2	38.6	2.00	50.8	59.0	55.5	20.3
109	RLPK...	52.0	43.8	11.8	7.9	56.5	35.9	2.00	47.6	70.7	51.9	25.5
110	0.......	54.0	50.0	12.7	7.5	27.3	25.9	(2.94)	31.2	49.3	46.1	17.5
		Oats[1]	Corn[3]	Oats	Soybeans	Wheat	Corn	Oats	Clover	Wheat	Corn	Oats
201	0.......	19.5	35.4	45.5	(1.28)	11.2	17.1	63.8	(2.74)	21.7	44.3	28.4
202	M......	19.1	47.4	55.3	(1.41)	17.9	21.4	71.6	(2.79)	18.9	66.4	45.2
203	ML.....	16.9	36.9	51.6	(1.38)	14.5	21.5	70.6	(2.78)	19.0	75.1	42.2
204	MLP....	20.9	56.8	56.1	(1.45)	23.2	21.0	72.3	(2.61)	18.6	76.7	39.2
205	0.......	18.9	38.7	45.9	14.2	7.0	15.2	65.9	(2.06) 1.00	20.3	53.2	31.2
206	R.......	18.1	52.1	45.9	16.7	16.2	26.7	69.8	(2.18) .83	19.8	59.2	32.0
207	RL......	18.9	50.5	48.3	18.3	16.1	26.8	82.8	(2.18) .58	19.3	65.7	34.2
208	RLP....	20.9	54.4	52.2	19.6	30.2	26.9	77.5	(2.54) .58	20.0	70.1	39.8
209	RLPK...	17.5	55.5	47.7	17.1	29.2	24.6	83.6	(2.29) .42	21.2	71.6	41.9
210	0.......	25.0	36.2	45.5	(1.40)[7]	14.8	15.1	65.9	(2.60)	20.3	46.1	30.6

TABLE 6.—CLAYTON FIELD, *Concluded*

		1911 Soy-beans[1]	1912 Barley[4]	1913 Corn	1914 Oats	1915 Soy-beans	1916 Wheat	1917 Corn	1918 Oats	1919 Soy-beans	1920 Wheat	1921 Corn
301	0.......	12.0	19.6	35.4	10.0	(2.52)	1.6	30.4	38.6	(1.55)	16.4	30.1
302	M......	12.5	19.7	55.2	14.7	(2.58)	2.0	52.8	49.2	(1.66)	30.8	52.3
303	ML.....	13.0	20.2	55.1	13.3	(2.83)	3.9	61.2	50.6	(1.86)	27.5	67.9
304	MLP....	12.8	22.6	58.4	15.9	(3.11)	4.6	60.5	53.9	(1.62)	32.8	67.7
305	0.......	14.6	21.5	42.1	13.9	12.5	1.8	35.2	37.5	23.1	11.0	42.3
306	R.......	14.4	21.4	49.7	17.3	12.5	4.4	52.6	46.9	20.8	11.5	58.4
307	RL......	14.8	22.2	52.2	16.6	19.2	5.6	59.9	57.0	23.5	19.6	65.0
308	RLP....	14.8	24.5	55.1	18.4	19.6	7.5	65.6	73.4	25.0	21.9	66.0
309	RLPK...	14.8	30.8	52.6	16.9	22.5	9.0	64.0	69.7	27.5	22.7	73.3
310	0.......	13.8	18.9	43.6	14.7	(2.21)	1.7	20.3	35.3	(1.38)	19.2	43.9
		Oats[1]	Soy-beans[2]	Wheat[6]	Corn	Oats	Clover	Wheat	Corn	Oats	Clover	Wheat
401	0.......	27.0	16.4	32.9	36.0	58.1	(2.30)	18.0	20.2	42.5	(1.70)	21.4
402	M......	32.2	(1.36)	31.0	37.8	61.6	(2.77)	21.7	49.8	50.3	(2.44)	29.1
403	ML.....	30.0	(1.36)	31.6	48.7	64.5	(2.76)	21.6	57.1	51.4	(2.64)	32.0
404	MLP....	30.8	(1.36)	34.0	46.1	69.5	(2.51)	23.5	50.4	49.5	(2.53)	32.1
405	0.......	32.8	17.5	34.1	29.9	60.5	1.83	20.4	22.1	45.0	(1.40) .96	22.6
406	R.......	33.3	16.7	33.3	30.4	50.5	1.58	26.7	33.7	46.7	(1.64) .83	24.1
407	RL......	33.3	16.9	33.8	41.6	62.5	1.00	21.5	44.6	43.0	(2.92) .80	29.1
408	RLP....	39.3	17.2	37.0	31.9	68.0	1.00	23.2	42.5	48.0	(2.55) 1.71	31.4
409	RLPK...	34.7	16.3	37.3	45.5	65.6	1.25	24.7	51.5	51.9	(3.10) .96	30.2
410	0.......	35.6	17.5	35.0	34.8	62.2	(2.15)	16.0	24.4	47.8	(1.98)	22.3

[1]No treatment. [2]Residues only. [3]No lime. [4]No manure or lime. [5]No manure, phosphate or potassium. [6]No manure. [7]Estimated.

There are four series of plots, the series numbering by hundreds from north to south. Each series has fourteen plots numbering in order from west to east and separated by half-rod division strips. Plots A, B, C, and D have only recently been added to the regular series, and no results are reported for these plots at this time.

The crop rotation practiced on this field is wheat, corn, oats, and clover. Soybeans have several times been substituted for the clover. The yields of all the crops grown each year since the beginning of the experiments are presented in Table 6. These results are summarized in Table 7, which shows the average yields of the respective crops for each treatment covering the years that full treatment has been under way. The lower section of this table gives a more condensed summary which affords some interesting comparisons. Here the results from the corresponding plots of the live-stock and grain systems are so combined as to bring out the effect of organic manures alone, organic manures in combination with limestone, and organic manures in combination with limestone and phosphorus.

TABLE 7.—CLAYTON FIELD: GENERAL SUMMARY
Average Annual Yields—Bushels or (tons) per acre 1913-1921

Serial plot No.	Soil treatment applied	Wheat 7 crops	Corn 9 crops	Oats 9 crops	Legumes[1] 8 crops
1	0	16.8	30.5	36.5	(2.01)
2	M	21.5	45.9	45.3	(2.26)
3	ML	23.0	51.5	44.2	(2.54)
4	MLP	26.0	50.4	46.7	(2.44)
5	0	16.6	33.0	38.5	(2.04)
6	R	19.5	44.0	41.4	(2.10)
7	RL	22.4	52.1	47.6	(2.27)
8	RLP	26.4	52.5	52.4	(2.35)
9	RLPK	26.4	56.7	51.7	(2.41)
10	0	17.9	33.9	41.6	(2.05)
4, 8	M, R } LP	26.2	51.5	49.6	(2.40)
3, 7	M, R } L	22.7	51.8	45.9	(2.41)
2, 6	M, R	20.5	45.0	43.4	(2.18)
1, 5, 10	0	17.1	32.5	38.9	(2.03)

[1]These figures represent the average combined yields of clover and soybeans, whether hay or seed, expressed as the equivalent of clover hay.

In looking over these results, attention is called first to the beneficial effect of organic manures, whether they have been applied in the form of animal manure or as plant manures (crop residues and legumes turned under). This improvement obtained by adding organic matter indicates the importance of carefully conserving and regularly applying all available farm manure. If farm manure is not available in sufficient quantity, then, as these results demonstrate, the necessary organic matter can be supplied by returning to the land all unused crop residues and by plowing under legume crops.

The results also bring out the beneficial effect of limestone on this soil, all crops showing in the general averages increases in yield where this material has been applied.

The use of raw rock phosphate applied along with organic manures and limestone has produced still further increases for wheat and oats, but not for corn. Potassium salts appear to have benefited the corn, but not the wheat and oats, altho the increase in corn yield would not pay for the cost of the treatment.

On the whole, the results of the Clayton field are in accord with what has been found to be generally true of the brown silt loam type of soil. For the establishment of a permanent system of fertility, organic matter and phosphorus are needed, and where limestone is lacking this material should be applied. Where organic manures, limestone, and phosphate have been applied on the Clayton field, the yield of wheat has averaged 26.2 bushels per acre as compared with 17.1 bushels on the check plots, an increase amounting to ½ of the crop that was produced without treatment; the yield of corn has averaged 51.5 bushels as compared with 32.5 bushels, also an increase of more than 50 percent; the yield of oats has averaged 49.6 bushels as compared with 38.9 bushels, representing about a 25 percent increase; the yield of hay, or its equivalent (the value of seed crops produced being expressed as the equivalent to tons of hay), has averaged 2.40 tons per acre as compared with 2.03 tons, an increase of about ⅙ of the untreated crop.

YELLOW-GRAY SILT LOAM

Yellow-gray silt loam exhibits an important variation with respect to limestone content. In some areas, altho limestone may be altogether absent in the surface stratum it is found in abundance at a short distance beneath the surface. Accordingly, variations in response to soil treatment are exhibited by different experiment fields located on this type. In view of this discrepancy it is thought well to introduce here the records of two fields, that are representative of the type but which show a marked diversity in results, one in northern Illinois and one in the southern part of the state.

The Antioch field is located on the late Wisconsin glaciation, in Lake county, close to the Wisconsin border. The field was started in 1902, with but a single series of ten plots, under a rotation of corn, corn, oats, and wheat; but beginning with 1911 the rotation has been wheat, corn, oats, and clover. It was started in order to learn as quickly as possible what effect would be produced by the addition to this type of soil of nitrogen, phosphorus, and potassium, used singly and in combination. Therefore these elements were all applied in commercial form until 1911, after which the use of commercial nitrogen was discontinued and crop residues were substituted in its place. Nitrogen was supplied in the earlier years in 800 pounds of dried blood per acre. Phosphorus is applied in 200 pounds of steamed bone meal, and potassium in 100 pounds of potassium sulfate. At the beginning, 470 pounds of slaked lime was applied; but since 1912 limestone has been applied at the rate of 1,000 pounds per acre per year.

Table 8 presents, in summarized form, the results from the Antioch field. Because of an abnormality in Plot 1, the results from this plot are not considered. The data show that phosphorus is the one element standing out prominently as producing consistently beneficial results. Potassium applied in addition to phosphorus has, on the whole, not produced profitable results. Also, the

TABLE 8.—ANTIOCH FIELD: YELLOW-GRAY SILT LOAM, TIMBER SOIL; LATE WISCONSIN GLACIATION

Average Annual Yields—Bushels or (tons) per acre
1902-1921

Serial plot No.	Soil treatment applied	Corn 8 crops	Oats 5 crops	Wheat 4 crops	Clover[1] 3 crops
1	0	23.9	32.3	15.8	1.33
2	L	21.3	26.8	13.2	1.26
3	LR	21.3	29.9	20.6	1.45
4	LP	30.7	43.6	36.7	1.61
5	LK	23.7	27.8	19.2	1.21
6	LRP	33.8	43.3	33.3	1.13
7	LRK	24.3	26.9	20.8	1.22
8	LPK	25.1	38.2	30.9	1.51
9	LRPK	38.3	42.6	28.0	1.00
10	RPK	38.4	44.7	30.2	1.28

[1] These figures represent the average combined yields of hay and seed, expressed as the equivalent of clover hay.

Lime applied and residues plowed under

Lime and phosphorus applied

FIG. 5.—CLOVER IN 1913 ON ANTIOCH FIELD

results are unfavorable for the application of limestone. Limestone, however, is abundant in the subsoil of this type in the region of this field.

The Raleigh experiment field is located on the lower Illinoisan glaciation, in southern Illinois, in Saline county. This field is laid out into four series of ten plots each, under a rotation of wheat, corn, oats, and clover. The treatments, along with the summarized results, are given in Table 9.

The outstanding feature of these results is the effect of limestone. Altho manure alone produces a substantial increase, especially in the corn crop, when

Manure, limestone, phosphorous
Yield: 61 bushels per acre

Nothing applied
Yield: 15 bushels per acre

FIG. 6.—CORN ON RALEIGH FIELD IN 1920

TABLE 9.—RALEIGH FIELD: YELLOW-GRAY SILT LOAM, TIMBER SOIL; LOWER ILLINOISAN GLACIATION

Average Annual Yields—Bushels or (tons) per acre
1911-1921

Serial plot No.	Soil treatment applied	Corn 11 crops	Oats 11 crops	Wheat 7 crops	Legumes[1] 9 crops
1	0	15.8	10.2	6.2	(.42)
2	M	27.6	12.5	7.9	(.55)
3	ML	39.0	19.6	21.7	(1.14)
4	MLP	40.0	19.8	22.5	(1.36)
5	0	16.4	10.0	7.3	(.14)
6	R	19.4	12.8	8.8	(.19)
7	RL	34.3	21.2	19.7	(.71)
8	RLP	36.7	22.4	22.4	(.81)
9	RLPK	42.7	23.0	23.8	(.81)
10	0	20.2	11.2	6.9	(.30)

[1] These figures represent the average combined yields of clover and soybeans, whether hay or seed, expressed as the equivalnt of clover hay.

limestone is added a remarkable increase is found in all crops. A most important fact is that the organic matter can be effectively built up thru the use of crop residues, with the application of limestone, so that the crop yields are practically as high under this "grain system" of farming as where manure is used.

Phosphorus thus far has given only moderate returns in increased crop yields, but with an increasing quantity of organic matter and nitrogen it is probable that the phosphorus applications will show up more favorably on subsequent crops. As to the use of potassium, it is to be noted that aside from an

increase of 6 bushels of corn in the residues system, the beneficial effect has not been sufficient to justify the use of this material.

In accounting for the discrepancy in the response to limestone on these two fields, the fact is to be considered that the Antioch field is located on the late Wisconsin glaciation, where the subsoil contains large quantities of limestone; while the Raleigh field represents the lower Illinoisan glaciation, the soil of which is very acid to a great depth.

In view of these variations, a general recommendation for a complete treatment for soil of this type, that will apply to all localities, cannot be given out until more information is acquired.

Fortunately, however, each farmer can determine for himself the need of limestone for his land by applying the simple tests for the presence of carbonates and soil acidity, as explained under the discussion of limestone on pages 36 and 37 of the Appendix.

Phosphorus, which has paid well on the Antioch field, and has given doubtful returns thus far at Raleigh, has varied considerably in its effect when used on other fields located on this same type of soil. In this situation, therefore, the present suggestion would be that each farmer might well try out phosphorus on his own land, on a limited scale, and be guided by the outcome of his experience. The low phosphorus content of the surface stratum of this soil is an indication that in a system of permanent agriculture the time is not far off when phosphorus will become a limiting element to crop production, and the wise farmer will watch carefully the indications and be ready to make timely provision for this need.

YELLOW SILT LOAM

Because such a large proportion of the area of Adams county is made up of yellow silt loam it is thought that an account of some experiments on the Vienna field, the single representative of this type of soil, would be of interest here.

The Vienna Field

In 1906 the University acquired a sixteen-acre tract of land representative of yellow silt loam near Vienna in Johnson county. The whole area with the exception of about three acres had been abandoned because so much of the surface soil had washed away and there were so many gullies as to render further cultivation of this land unprofitable. Experiments were started at once to reclaim this land, the different methods described below being used for this purpose.

The field was divided into five sections. The sections designated as A, B, and C were divided into four plots each, and D into three plots. On section A, which included the steepest part of the area and contained many gullies, the land was built up into terraces at vertical intervals of five feet. Near the edge of each terrace a small ditch was placed so that the water could be carried to a natural outlet without doing much washing.

On section B the so-called embankment method was used. By this method erosion is prevented by plowing up ridges sufficiently high so that on the occasion of a heavy rainfall if the water breaks over it will run over in a broad

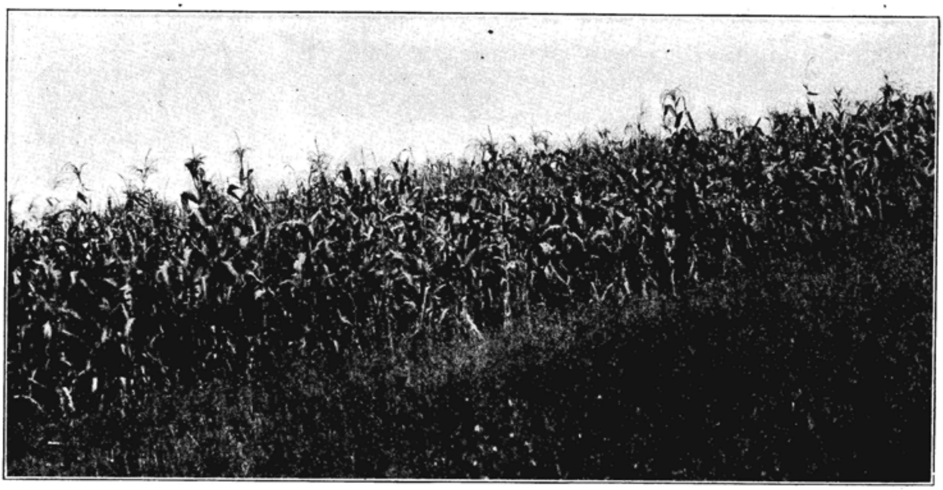


FIG. 7.—CORN CROP ON THE VIENNA EXPERIMENT FIELD GROWING ON IMPROVED HILLSIDE LAND THAT HAD BEEN FORMERLY BADLY ERODED. COMPARE WITH FIG. 8

sheet rather than in narrow channels. At the steepest part of the slope, hillside ditches were made for carrying away the run-off.

Section C was washed badly but contained only small gullies. Here the attempt was made to prevent washing by incorporating organic matter in the soil and practicing deep contour plowing and contour planting. With two exceptions, each year about eight loads of manure per acre were turned under for the corn crop.

The land on section D was washed to about the same extent as that of section C. As a check on the different methods of reducing erosion, the land on section D was farmed in the most convenient way, without any special effort being made to prevent washing.

FIG. 8.—VIEW OF UNIMPROVED HILLSIDE LAND TAKEN JUST OVER THE FENCE FROM THE FIELD SHOWN IN FIG. 7

Section E was badly eroded and gullied and no attempt was made to crop it other than to fill in the gullies with brush and to seed the land to grass.

Sections A, B, C, and D were not entirely uniform; some parts were washed more than others and portions of the lower-lying land had been affected by soil material washed down from above. When the field was secured, the higher land had a very low producing capacity. On many spots little or nothing would grow.

Limestone was applied to the entire field at the rate of 2 tons per acre. Corn, cowpeas, wheat, and clover were grown in a four-year rotation on each section except D which had but three plots.

Table 10 contains a summarized statement of the results obtained.

TABLE 10.—VIENNA FIELD: METHODS OF HANDLING HILLSIDE LAND TO PREVENT EROSION

Average Annual Yields—Bushels or (tons) per acre
1907-1915

Section	Method	Corn 7 crops	Wheat 7 crops	Clover 3 crops
A	Terrace	31.4	9.0	(0.68)
B	Embankments and hillside ditches	32.4	12.7	(0.97)
C	Organic matter, deep contour plowing, and contour planting	27.9	11.7	(0.80)
D	Check	14.1	4.6	(0.21)

These results indicate something of the possibilities in improving hillside land by protecting it from erosion. The average yield of corn from the protected series (A, B, and C) was 30.6 bushels per acre, as against 14.1 bushels for series D; wheat yielded 11.1 bushels in comparison with 4.6 bushels; and clover .82 ton in comparison with .21 ton.

A comparison of Figs. 7 and 8 will serve to indicate the possibility of improving this type of soil.

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(3) email: program.intake@usda.gov.

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LEGEND

000 Residual
200 Illinoisan Moraines
500 Upper Illinoisan Intermorainal Areas
800 Deep Loess Areas
1300 Old Bottom Land
1400 Late Swamp and Bottom Land
1500 Terraces

(a) UPLAND PRAIRIE SOILS

- 26 — Brown silt loam
- 28 — Brown-gray silt loam on tight clay
- 25.1 / 525.1 — Black silt loam on clay
- 71 / 871 — Brown fine sandy loam

(b) UPLAND TIMBER SOILS

- 34 — Yellow-gray silt loam
- 35 — Yellow silt loam
- 74 / 874 — Yellow-gray fine sandy loam
- 75 / 875 — Yellow fine sandy loam
- 65 — Yellow sandy loam

(c) 1500 TERRACE SOILS

- 1526 — Brown silt loam
- 1560 — Brown sandy loam
- 1528 — Brown-gray silt loam on tight clay
- 1534 — Yellow-gray silt loam
- 1536 — Yellow-gray silt loam over gravel
- 1564 — Yellow-gray sandy loam

(d) 1300 OLD BOTTOM-LAND SOILS

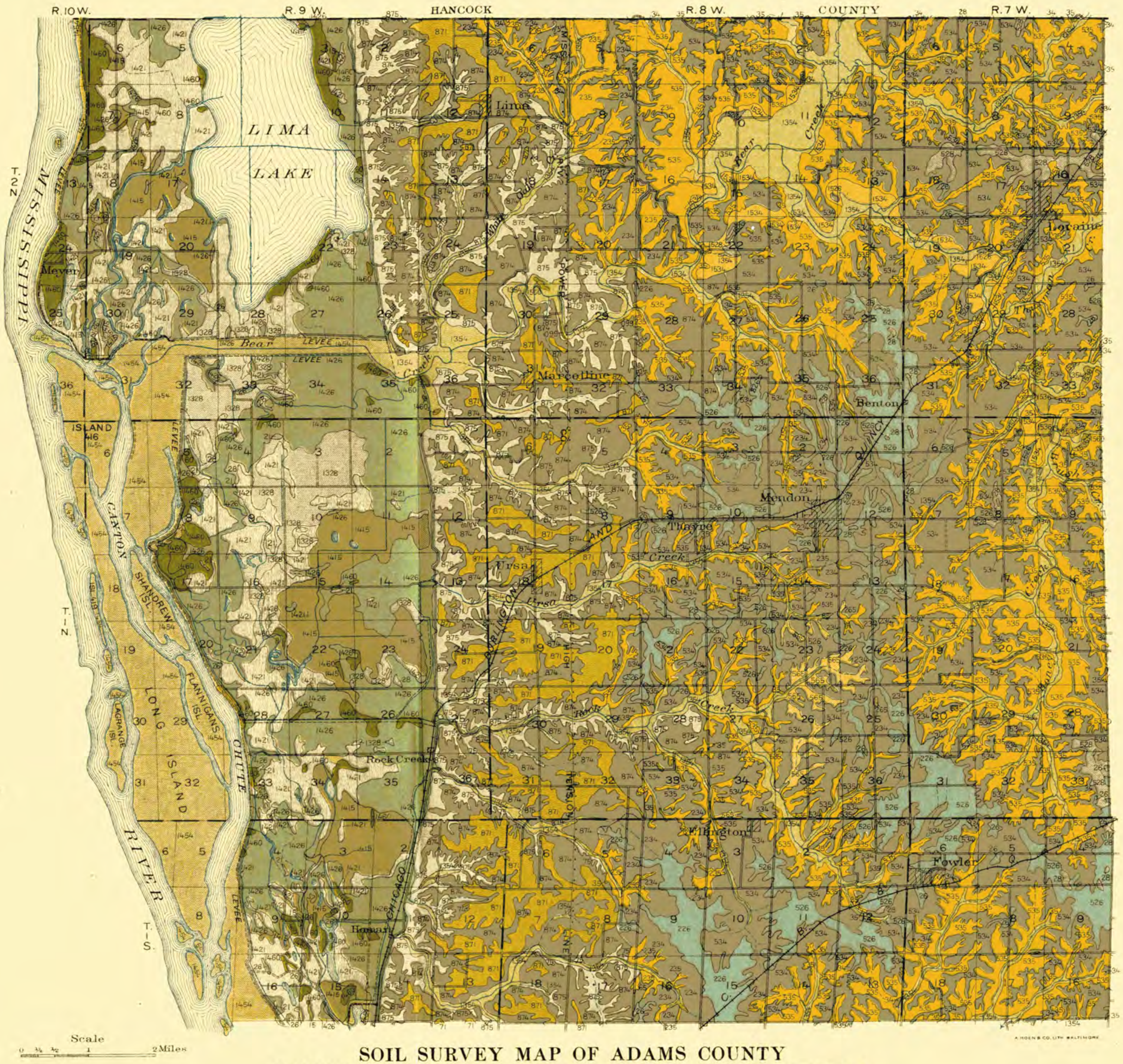
- 1328 — Brown-gray silt loam on tight clay
- 54 / 1354 — Mixed loam (small stream bottoms)

(e) 1400 LATE SWAMP AND BOTTOM-LAND SOILS

- 1426 — Brown silt loam
- 1460 — Brown sandy loam
- 15 / 1415 — Drab clay
- 21 / 1421 — Drab clay loam
- Sandy drab clay loam
- 1454 — Mixed loam (Mississippi overflow)

(f) 000 RESIDUAL

- 099 — Rock outcrop
- Small areas rock outcrop



SOIL SURVEY MAP OF ADAMS COUNTY
UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION

LEGEND

000 Residual
200 Illinoisan Moraines
500 Upper Illinoisan Intermorainal Areas
800 Deep Loess Areas
1300 Old Bottom Land
1400 Late Swamp and Bottom Land
1500 Terraces

(a) UPLAND PRAIRIE SOILS

- 26 Brown silt loam
- 28 Brown-gray silt loam on tight clay
- 25.1 525.1 Black silt loam on clay
- 71 871 Brown fine sandy loam

(b) UPLAND TIMBER SOILS

- 34 Yellow-gray silt loam
- 35 Yellow silt loam
- 74 874 Yellow-gray fine sandy loam
- 75 875 Yellow fine sandy loam
- 65 Yellow sandy loam

(c) 1500 TERRACE SOILS

- 1526 Brown silt loam
- 1560 Brown sandy loam
- 1528 Brown-gray silt loam on tight clay
- 1534 Yellow-gray silt loam
- 1536 Yellow-gray silt loam over gravel
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- 1426 Brown silt loam
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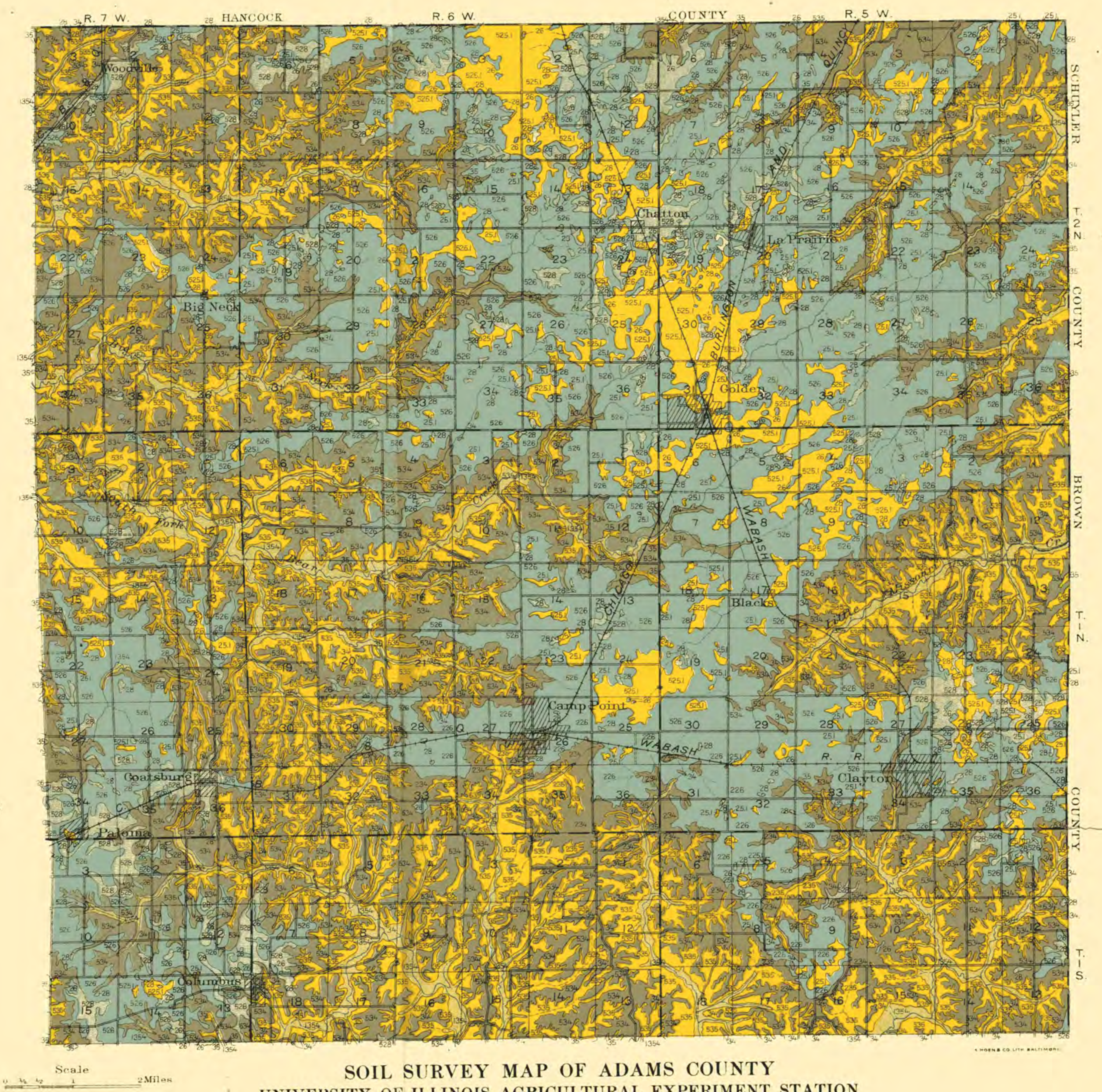
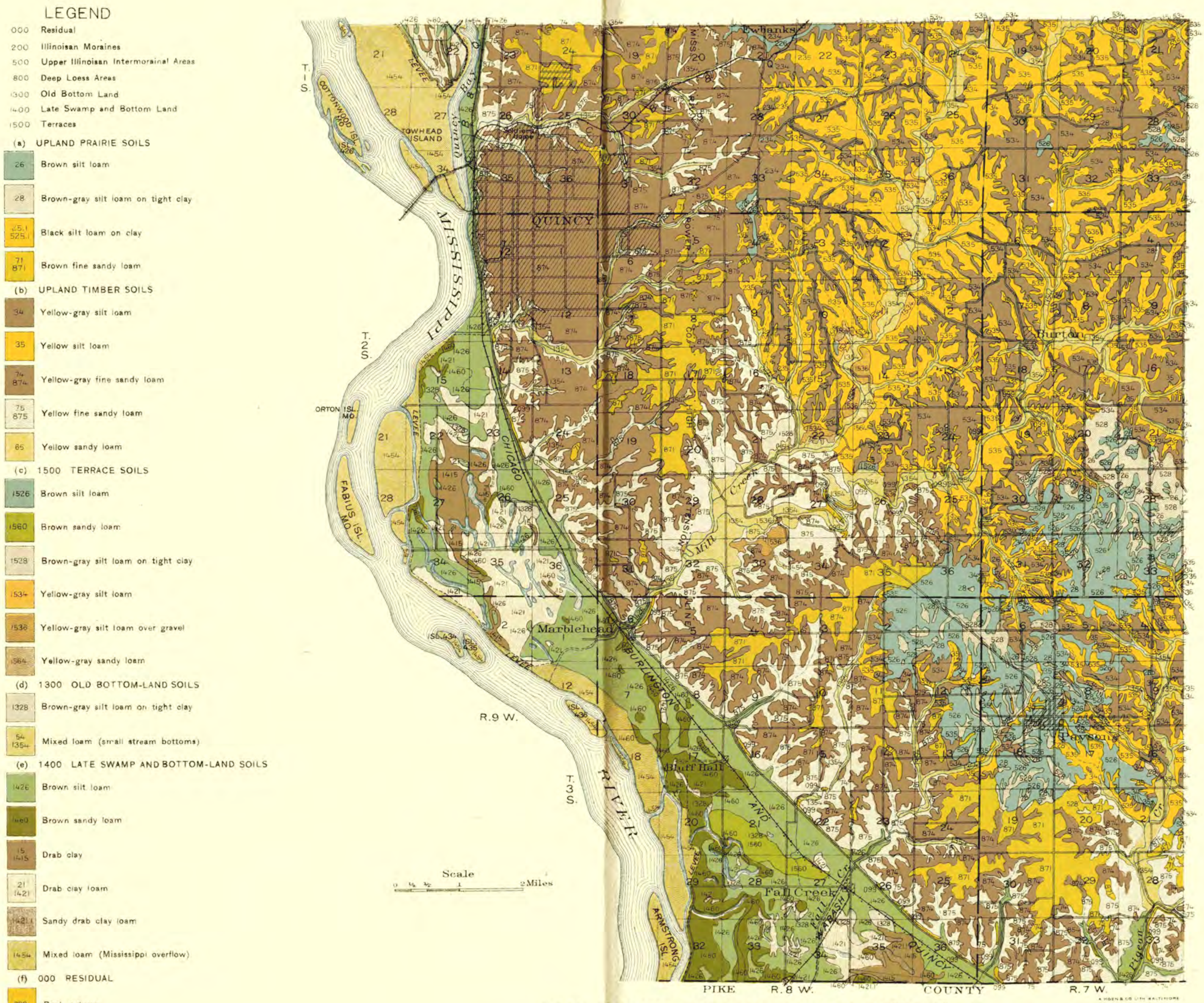
- 15 1415 Drab clay
- 21 1421 Drab clay loam
- 1421 Sandy drab clay loam
- 1454 Mixed loam (Mississippi overflow)

(f) 000 RESIDUAL

- 099 Rock outcrop
- Small areas rock outcrop



SOIL SURVEY MAP OF ADAMS COUNTY
UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION



SOIL SURVEY MAP OF ADAMS COUNTY
UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION

LEGEND

- 000 Residual
- 200 Illinoisan Moraines
- 500 Upper Illinoisan Intermorainal Areas
- 600 Deep Loess Areas
- 1300 Old Bottom Land
- 1400 Late Swamp and Bottom Land
- 1500 Terraces

(a) UPLAND PRAIRIE SOILS

- 26 Brown silt loam
- 28 Brown-gray silt loam on tight clay
- 25.1 / 525.1 Black silt loam on clay
- 71 / 871 Brown fine sandy loam

(b) UPLAND TIMBER SOILS

- 34 Yellow-gray silt loam
- 35 Yellow silt loam
- 74 / 874 Yellow-gray fine sandy loam
- 75 / 875 Yellow fine sandy loam
- 65 Yellow sandy loam

(c) 1500 TERRACE SOILS

- 1526 Brown silt loam
- 1560 Brown sandy loam
- 1528 Brown-gray silt loam on tight clay
- 1534 Yellow-gray silt loam
- 1536 Yellow-gray silt loam over gravel
- 1564 Yellow-gray sandy loam

(d) 1300 OLD BOTTOM-LAND SOILS

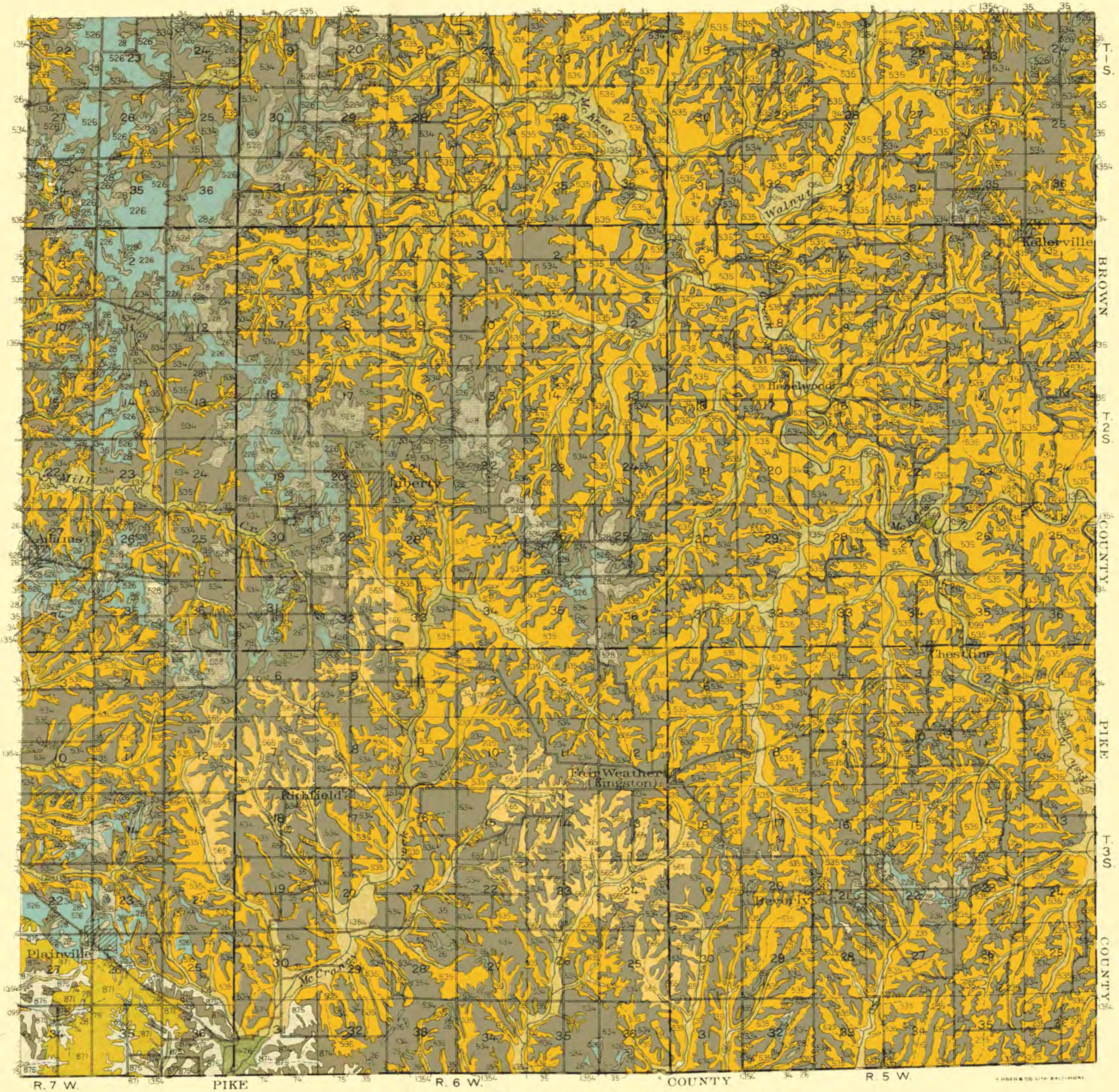
- 1328 Brown-gray silt loam on tight clay
- 54 / 1354 Mixed loam (small stream bottoms)

(e) 1400 LATE SWAMP AND BOTTOM-LAND SOILS

- 1426 Brown silt loam
- 1460 Brown sandy loam
- 15 / 1415 Drab clay
- 21 / 1421 Drab clay loam
- 1421.1 Sandy drab clay loam
- 1454 Mixed loam (Mississippi overflow)

(f) 000 RESIDUAL

- 099 Rock outcrop
- Small areas rock outcrop



Scale 0 ¼ ½ 1 2 Miles

SOIL SURVEY MAP OF ADAMS COUNTY

UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION